B I D D I N G D O C U M E N T

for

The Work of Design, Engineering, Construction and Commissioning 10 MLD Sewage Treatment Plant with Biological Nutrient Removal (BNR) at Anjanapura-2 BDA layout with 10 MLD TSPS, Pumping Main and Operation & Maintenance for Seven Years.

(DBO contract)

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PART 10A

CIVIL, STRUCTURAL AND SEWER NETWORK REQUIREMENTS

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SECTION 1

SITE CLEARANCE (CLEARING AND GRUBBING)

SECTION 1

SITE CLEARANCE (CLEARING AND GRUBBING)

1.1 Scope

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., from the area of Works which in the opinion of the Engineer are unsuitable for incorporation in the Works, and such other areas as may be specified on the Drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications.

1.2 Preservation of Property/Amenities

Trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all facilities within or adjacent to the site which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own expense, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional Works to that effect vide relevant Clauses of section 3 Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc., and the schedules for carrying out temporary and permanent erosion control Works as stipulated in section 3.

1.3 Methods, Tools and Equipment

Only such methods, tools and equipment as are approved by the Engineer and which will not affect the property to be preserved shall be adopted for the Work. If the area has thick vegetation / roots / trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade / foundation / bed level. Also, all vegetation such as roots, under-growths, grass and other deleterious matter unsuitable for incorporation in the Work shall be removed between fill lines to the satisfaction of the Engineer. On the areas beyond these limits, trees and stumps required to be removed as

directed by the Engineer shall be cut down to 1 m below ground level so that these do not present any unsightly appearance.

All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface as these points conform to the surrounding area.

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several meters, shall be suitably treated.

1.4 Disposal of Materials

All materials arising from clearing and grubbing operations shall be the property of Employer and shall be disposed of by the Contractor as here in after provided or directed by the Engineer.

Trunks and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in construction shall be neatly stacked as directed by the Engineer. Stacking stumps, boulders, stones etc., shall be done at specified spots with all lifts and lead.

All products of clearing and grubbing which, in the opinion of the Engineer, cannot be used or auctioned shall be cleared away from the site in a manner as directed by the Engineer. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

1.5 Measurements for Payment

Clearing and grubbing shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of Works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same. Cutting of trees up to 300 mm in girth including removal of stumps and roots, and trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps left over after trees have been cut by any other agency shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots of trees of girth above 300 mm and backfilling to required compaction shall be measured in terms of number according to the sizes given below:

Above 300 mm to 600 mm;
Above 600 mm to 900 mm;
Above 900 mm to 1800 mm; and

Above 1800 mm.

For this purpose, the girth shall be measured at a height of 1 m above ground or at the top of the stump if the height of the stump is less than 1 m from the ground.

1.6 Rates

The Contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm in girth as well as stumps left over after cutting of trees carried out by another agency, excavation and back-filling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and leads.

The Contract unit rates for cutting (including removal of stumps and roots) of trees of girth above 300 mm shall include excavation and back-filling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and lead.

Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

End of Section-1

SECTION 2

DISMANTLING AND DEMOLITION

SECTION 2

DISMANTLING AND DEMOLITION

2.1 Scope

This work shall consist of removing, as hereinafter set forth, existing buildings, roofs, ceiling, flooring and paving, concrete and brick roofs and suspended floors, walls and columns, reinforced concrete and brick work, partitions, wood work, steel and iron work, doors and windows, pipes and sewer lines, posts or struts, fencing wire mesh, glazing, culverts, bridges, pavements, kerbs and other structures like guard-rails, utility services, catch basins, inlets, etc., which are in place but interfere with the new construction or are not suitable to remain in place, and of salvaging and disposing of the resulting materials and back filling the resulting trenches and pits.

Existing culverts, bridges, pavements and other structures which are within the highway and which are designated for removal, shall be removed up to the limits and extent specified in the Drawings or as indicated by the Engineer.

Dismantling and removal operations shall be carried out with such equipment and in such a manner as to leave undisturbed, adjacent pavement, structures and any other work to be left in place.

All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.

2.2 Applicable Codes

IS: 1200-1974 (Part: XVIII)	Method of Measurements of Building and Civil Engineering Works. Demolition and Dismantling (Reaffirmed 2002) (3rd Revision).
IS: 4130-1991	Demolition of Buildings - Code of Safety (2nd Revision).

2.3 Terminology

The term ‘Dismantling’ implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the structure as specified.

The term 'Demolition' implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified.

2.4 Buildings

2.4.1 Precautions

All materials obtained from dismantling or demolition shall be the property of the Employer unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer.

The demolition shall always be well planned before hand and shall generally be done in reverse order of the one in which the structure was constructed. The operations shall be got approved from the Engineer-In-Charge before starting the work.

Due care shall be taken to maintain the safety measures prescribed in IS: 4130.

Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions shall also be provided, as directed by the Engineer.

Necessary precautions shall be taken to keep down the dust nuisance to the minimum.

Dismantling shall be done in a systemic manner. All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. The dismantled articles shall be removed manually or otherwise, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer.

Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off.

Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer within a lead of 50 m. All unserviceable materials rubbish etc. shall be disposed off as directed by the Engineer.

The Contractor shall maintain / disconnect existing services, whether temporary or permanent, where required by the Engineer.

2.4.2 Measurements

All work shall be measured net in the decimal system, as fixed in its place, subject to the following limits, unless otherwise stated hereinafter.

1. Dimensions shall be measured correct to a cm.
2. Areas shall be worked out in sq mt correct to two places of decimal.
3. Cubical contents shall be worked out to the nearest 0.01 cum.

Parts of work required to be dismantled and those required to be demolished shall be measured separately.

Measurements of all works except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed.

Specifications for deduction for voids, openings etc. shall be on the same basis as that adopted for new construction of the work.
Work executed in the following conditions shall be measured separately:

1. Work in or under water and / or liquid mud;
2. Work in or under foul position.

2.4.3 Rates

The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 m.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

2.5 Roofs

Roof coverings generally including battens boarding, mats, bamboo jaffari or other subsidiary supports shall be measured in sq mt except lead sheet roof covering, which shall be measured in tonnes and stone slab roof covering which shall be measured in cum.

Ridges, hips and valleys shall be girthed and included with the roof area. Corrugated or semi corrugated surfaces shall be measured flat and not girthed.

Mud phuska on roofs shall be measured in cum.

Lead sheets in roofs shall be measured in tonnes and hips, valleys, flashings, lining to gutter etc. shall be included in this weight.

R.B. or R.C.C. roofs shall be measured in cum and if reinforcement is required to be salvaged, it shall be so stated. When reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately as tonnes of salvaged steel.
Supporting members, such as rafters, purlins, beams joists, trusses etc. where of wood shall be measured in cum and steel or iron sections in tonnes.

2.6 Ceiling

The stripping of ceilings shall be measured in sqm.

Dismantling of supporting joists, beams, etc. shall be measured in cum or in tonnes.

Height above floor levels if it exceeds 3.5 m shall paid for separately.

2.7 Flooring and Paving

Dismantling of floors (except concrete and brick floors) shall be measured in sqm. Supports such as joints, beams etc. if any shall be measured as per Clause 2.5. Concrete and bricks paving shall be measured as per Clause 2.8.

2.8 Concrete and Brick Roofs and Suspended Floors

Demolition of floors and roofs of concrete or brick shall be measured in cum. Beams cantilevers or other subsidiary supports of similar materials shall be included in the item. In measuring thickness of roofs provided with water proofing treatments with bitumen, felts, the thickness of water proofing treatment shall be ignored.

2.9 Walls and Piers

Taking down walls and independent piers or columns of brick, stone or concrete shall be measured, in cum. All copings, corbels, cornices and other projections shall be included with the wall measurements.
In measuring thickness of plastered walls, the thickness of plaster shall be ignored.

Ashlar face stones, dressed stone work, precast concrete articles, etc. if required to be taken down intact shall be so stated, and measured separately in cum.

Cleaning bricks stacking for measurements including all extra handling and removal and disposing off the rubbish as stated shall be enumerated in thousand of cleaned bricks.

Cleaning stone obtained from demolished / dismantling stone masonry of any description including ashlar facing dressed stone work, stone slabs or flagging and precast concrete blocks including all extra handling and disposing of the rubbish as stated shall be measured in cum of cleaned stone.

Honey comb works or cavity walls of bricks stone or concrete shall be measured as solid.

2.10 Reinforced Concrete and Brick Work

Reinforced concrete structures and reinforced brick roof and walls shall be measured in cum and if reinforcement is required to be salvaged, it shall be so stated.

Where reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately in tonnes of salvaged steel.

2.11 Partitions, Trellis Work, Etc.

Partitions or light walls of lath and plaster, trellis work, expanded metal, thin concrete or terracotta slabs and other similar materials including frame work if any shall be measured in sqm stating the overall thickness.

2.12 Wood Work

All wood work including karries average 40 sq cm or over in section, shall be measured in cum, while that under 40 sq cm in section, in running metres. Ballies shall be measured in running metres.
Boarding including wooden chajjas and sun shades along with supports shall be measured in square m in its plane.

2.13 Steel and Iron Work

All steel and iron work shall be measured in tonnes. The weight shall be computed from standard tables unless the actual weight can readily be determined.
Riveted work, where rivets are required to be cut, shall be measured separately.

Marking of structural steel required to be re-erected shall be measured separately.

In framed steel items, the weight or any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately.

2.14 Doors and Windows

Dismantling of doors, windows, clerestory windows, ventilators etc. (Wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of chowkhats architraves, hold fasts and other attachments.

If only shutters are to be taken out it shall be measured separately.

2.15 Pipes and Sewer Lines

Water pipe lines including rain water pipes with clamps and specials, sewer lines (salt glazed ware or concrete) etc. shall be described by their diameter and length measured in running m inclusive of joints.

If the joints, special and fittings etc. are required to be separated, it shall be so stated and enumerated.

Pucca drains shall be measured under relevant items.

Value cistern, public fountain platform, fire hydrants, etc. shall be enumerated.

Manholes and inspection chambers shall be enumerated stating the size and depth of manhole/inspection chamber. They shall be classified into different groups depending upon the depth, in unit of half and one m depth. The depth of the manhole shall be the distance between the top of manhole cover and invert level of the drain.

Ventilating shafts, gully traps, flushing cisterns and other appurtenant items of work shall be enumerated.

2.16 Posts or Struts

Posts or struts (wood, steel or RCC) section including taking out embedded portion shall be measured in running m.

2.17 Fencing Wire Mesh

Wire mesh fencing of any type with frame shall be measured in square m.

2.18 Glazing

Taking out any portion of serviceable glass except polished plate, from old sashes, skylights, etc. (any thickness, weight or size) raking out old putty, etc. shall be measured in square m.

Irregular or circular panes shall be measured as rectangle or square enveloping the same, the width and height being measured correct to the nearest 0.5 cm.

2.19 Dismantling Culverts, Bridges and Other Structures/Pavements

2.19.1 Dismantling Culverts and Bridges

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures nearby.

Unless otherwise specified, the superstructure portion of culverts / bridges shall be entirely removed and other parts removed below the ground level or as necessary depending upon the interference they cause to the new construction. Removal of overlaying or adjacent material, if required in connection with the dismantling of the structures shall be incidental to this item.

Where existing culvert / bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the exiting structure shall be removed as are necessary and directed by the Engineer to provide a proper connection to the new work. The connecting edges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Due care should be taken to ensure that reinforcing bars which are to be left in place to project into the new work as dowels or ties are not injured during removal of concrete.

Pipe culverts shall be carefully removed in such manner as to avoid damage to the pipes.

Steel structures shall, unless otherwise provided, be carefully dismantled in such a manner as to avoid damage to members thereof. If specified in the Drawings or directed by the Engineer that the structure is to

be removed in a condition suitable for re-erection, all members shall be match-marked by the Contractor with white lead paint before dismantling; end pins, nuts, loose plates, etc., shall be similarly marked to indicate their proper location; all pins, pin holes and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts shall be securely wired to adjacent members or packed in boxes.

Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber when designated by the Engineer to be salvaged.

2.19.2 Dismantling Pavements and Other Structures

In removing pavements, kerbs, gutters and other structures like guard-rails, fences, manholes, catch-basins, inlets, etc. where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer.

All concrete pavements, base courses in carriageway and shoulders etc., designated for removal shall broken to pieces whose volume shall not exceed 0.02 cum and stockpiled at designated locations if the material is to be used later or otherwise arranged for disposal as directed (see Clause 2.19.4).

2.19.3 Back-filling

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density as directed by the Engineer.

2.19.4 Disposal of Materials

All materials obtained by dismantling shall be the property of Employer. Unless otherwise specified, materials having any salvage value shall be placed in neat stacks of like materials within the right-of-way, as directed by the Engineer with all lifts and up to a lead of 1000 m.

Pipe culverts that are removed shall be cleaned and neatly piled on the right-of-way at points designated by the Engineer with all lifts and lead up to 1000 m.

Structural steel removed from old structures shall, unless otherwise specified or directed, be stored in a neat and presentable manner on blocks in locations suitable for loading. Structures or portions thereof which are specified in the Contract for re-erection shall be stored in separate piles.
Timber or lumber from old structures which is designated by the Engineer as materials to be salvaged shall have all nails and bolts removed there from and shall be stored in neat piles in locations suitable for loading.

All materials obtained from dismantling operations which, in the opinion of the Engineer, cannot be used or auctioned shall be disposed of as directed by the Engineer with all lifts and up to a lead of 1000 m.

2.19.5 Measurements for Payment

The work of dismantling structures shall be paid for in units indicated below by taking measurements before and after, as applicable:

1.	Dismantling brick/stone masonry/concrete (plain and reinforced)	cum.
2.	Dismantling flexible and cement concrete pavement	cum.
3.	Dismantling steel structures	tonne
4.	Dismantling timber structures	cum.
5.	Dismantling pipes, guard rails, kerbs, gutters and fencing	linear m.
6.	Utility services	Nos.

2.19.6 Rates

The Contract unit rates for the various items of dismantling shall be paid in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. These will also include excavation and backfilling where necessary to the required compaction and for handling, salvaging, piling and disposing of the dismantled materials within all lifts and up to a lead of 1000 m.

End of Section-2

SECTION 3

EARTHWORKS

SECTION 3

EARTHWORKS

3.1 Applicable Codes

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

a) IS 783 - 1985 - Code of practice for laying of Concrete pipes.
(Reaffirmed 2017)

IS 4984 - 1995 - Code of practice for laying of HDPE pipes.

(Reaffirmed 2016)

IS 12288 - 1987 - Code of practice for use and laying of DI pipes.

(Reaffirmed 2017)

b) IS 3764 - 1992 - Excavation work - Code of Safety.
(Reaffirmed 2017)

c) IS 2720 - Methods of test for soils:
(Part-1) - 1983 - Preparation of dry soil samples for various tests.

(Reaffirmed 2015)

(Part-2) - 1973 - Determination of Water Content.

(Reaffirmed 2015)

(Part-4) - 1985 - Grain size analysis.

(Reaffirmed 2015)

(Part-5) - 1985 - Determination of liquid and plastic limit.

(Reaffirmed 2015)

(Part-7) - 1980 - Determination of water content - dry density relation using light compaction.

(Reaffirmed 2016)

(Part-9) - 1992 - Determination of dry density - moisture content by constant weight of soil method.

(Reaffirmed 2016)

(Part-14) - 1983- Determination of density index (relative density)

Cohesionless soils.

(Reaffirmed 2015)

(Part-22) - 1972 - Determination of organic matter.

(Reaffirmed 2015)

(Part-26) - 1987 - Determination of pH Value.

(Reaffirmed 2016)

(Part-27) - 1977- Determination of total soluble sulphates.

(Reaffirmed 2015)

(Part-28) - 1974- Determination of dry density of soils in place, by the sand replacement method.

(Reaffirmed 2015)

(Part-33)-1971 - Determination of the density in place by the ring and water replacement method.

(Reaffirmed 2015)

(Part-34) - 1972- Determination of density of soil in place by rubber balloon method.

(Reaffirmed 2015)

(Part-38) - 1976- Compaction control test (Hilf Method).

(Reaffirmed 2016)

3.2 Drawings

Engineer will furnish drawings wherever, in his opinion, such drawings are required to show areas to be excavated/filled grade level, sequence of priorities etc. Contractor shall follow strictly such drawings.

3.3 General

The Contractor shall furnish all tools, plant, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Specifications.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

The rates quoted shall also include for dumping of excavated material in regular heaps, bunds, riprap with regular slopes within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Engineer. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

Topsoil shall be stock piled separately for later re-use.

3.4 Clearing

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Engineer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

3.5 Classification

All materials to be excavated shall be classified by Engineer, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of Engineer regarding the classification of the material shall be final and binding on Contractor and not be a subject matter of any appeal or arbitration.

Any earthwork will be classified under any of the following categories:

a) Ordinary & Hard Soils

These shall include all kinds of soils containing kankar, sand, silt, moorum and/or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pick axes and shovel, and which is not classified under "soft and decomposed rock" and "hard rock" defined below. This shall also include embedded rock boulders not longer than 1 metre in any one direction and not more than 200 mm in any one of the other two directions.

b) Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite, highly weathered granite gneiss and all other materials which in the opinion of Engineer is rock, but does not need blasting and could be removed readily with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. The mere fact that Contractor resorts to blasting for reasons of his own, shall not qualify for classification under 'hard rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

c) Hard Rock

This shall include all rock occurring in large continuous masses which cannot be removed except by blasting, chiselling or by drilling with heavy mechanical breakers. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of Engineer require blasting shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

Before classification of material as rock the Contractor shall demonstrate to the satisfaction of the Employer's Representative his inability to excavate it without resort to heavy percussion tools complete with rock bits, hydraulic wedges or blasting. Excavation by the use of explosive will not normally be permitted.

Material shall not be classified as rock unless the Employer's Representative has agreed to such classification on the basis of such a demonstration before its excavation. Excavations where rock has been encountered and classified as such shall not be backfilled before examination of the excavated faces by the Employer's Representative to enable the extent of the rock excavation to be determined.

3.6 Excavation

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Engineer, the work involved requires it to be carried out by manual methods.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings provided by the Contractor or such other lines and grades as may be

agreed with the Engineer. Rough excavation shall be carried out to a depth of 150mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with lean concrete of grade M10 with 20 mm downgraded aggregates as approved by the Engineer. The final excavation should be carried out just prior to laying the blinding course.

Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by Engineer, at his own cost outside the lines shown on the drawings or directed by Engineer. Should any excavation be taken below the specified elevations, Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by Contractor on this account.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for if the slips are due to the negligence of Contractor.

3.7 Stripping Loose Rock

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Engineer, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Engineer, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

3.8 Excavation in Hard Rock

3.8.1 General Requirements

Unless otherwise stated herein, I.S Specification "IS- 4081(1986) Safety code for Blasting and related Drilling Operations" shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosive used shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by the Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of the Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Specific permission of the Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting Licence from the authorities concerned. If permission for blasting is refused by the Engineer, the rock shall be removed by wedging, pick, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from Employer's stores or from supplier arranged by him, from the authorities dealing with explosives. The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Government authorities and Statutory bodies/regulations. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as for as possible away from the area to be blasted, Engineer's prior approval shall be taken for the location proposed for the magazine.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Excavation in hard rock shall be only by chiseling / Jack hammering or by drilling with mechanical breakers.

The rock shall be removed by wedging, pick, boring, heating and quenching or other approved non-blasting methods. All loose or loosened rock in the sides shall be removed by barring, wedging etc. The unit rate for excavation in hard rock shall include the cost of all these operations. No blasting is allowed.

3.8.2 Specific Requirements

For blasting operations, the following points shall be observed.

Contractor shall employ a competent and experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are excluded from a area within 200 m. radius from the firing point, at least 5 minutes before firing time by sounding warning whistle. The area shall also be given warning by sounding a distinguishing whistle.

The blasting of rock near any existing buildings, equipment or any other property shall be done under cover if permitted by the Engineer and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Engineer, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully

located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or stone dust or similar inert material.

Contractor shall preferably detonate the explosives electrically.

The explosives shall be exploded by means of a primer which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D shall be connected by special nippers.

In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatine with detonator and fuse wire may be used. For excavation in rock with substantial accumulated seepage electric detonation shall be used. Holes for charging explosive shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stopping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other Authority duly constituted under the State and /or Union Government.

3.9 Fill, Backfilling and Site Grading

3.9.1 General

All fill material shall be subject to the Engineer's approval. If any material is rejected by Engineer, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Engineer after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Engineer.

The Contractor shall not commence the placement of any fill or backfill at any location without the approval of the Engineer.

3.9.2 Material

To the extent available, selected surplus soils from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Engineer. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed off as directed by Engineer. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist, at his cost.

3.9.3 Filling in pits and trenches around foundations of structures, walls, etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Engineer. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction

shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Engineer.

3.9.4 Plinth Filling

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The Engineer may, however, permit manual compaction by hand tampers where he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlement at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of the plinth fill shall be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this case be upto a maximum of 300mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Engineer obtained prior to commencing filling.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of Engineer, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

At some locations/areas, it may not be possible to use rollers because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

3.9.5 Sand Filling in Plinth and Other Places

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be on Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

3.9.6 Filling in Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murum, etc. The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

In the case of water transmission, pipe lines works etc for water transfer, the Contractor shall take proper precautions against the risks of floatation. Should any section of the pipeline be affected by floatation in the course of works the entire work shall be removed and then reinstalled to the satisfaction of Engineer.

3.10 General Site Grading

Site grading shall be carried out as indicated in the drawings and as approved by the Engineer. Excavation shall be carried out as specified in the Specifications. Filling and compaction shall be carried out as specified under Clause 3.9 and elsewhere unless otherwise indicated below.

The fill has to be compacted in layers not exceeding 225 mm and leveled uniformly and compacted as indicated in Clause 3.9 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his cost.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 ton roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

3.11 Fill Density

The compaction, where so called for, shall comply with minimum 95% Modified Proctor density at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

3.12 Lead

Lead for deposition/disposal of excavated material, shall be as specified in the respective item of work. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or 'katcha' land/route.

3.13 Measurement and Payment

All excavation shall be measured net. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations/structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings. Excavations in side slopes will not be paid for. Contractor may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety or excavation. Reasonable working space, beyond concrete dimensions and shuttering where considered necessary in the opinion of Engineer will be allowed in excavation and considered for payment. However, if concreting is proposed against the excavated sides, no such over-excavation will be permitted. In such cases over-excavation shall be made good by Contractor with concrete of the same class as in the foundations at his cost.

In the case of water transmission, pipe lines works etc for water transfer trench excavation shall be measured using the dimensions detailed in the standard section shown on the Drawings. No payment will be made for working space except where clearly mentioned on the drawings. Excavation beyond the widths or depths required will not be paid for any additional concrete or bedding material required as a result of over-excavation at the Contractor's expense.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation including backfilling shall include stacking of excavated material as directed, excavation/packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule material to be backfilled shall be stacked temporarily within the site as directed by the Engineer

Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified/directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. Payment for this work will be made based on measurement of plinth/trench dimensions as per drawings. The plinth ground levels shall be

surveyed before hand for this purpose. If no compaction is specified/desired such filling will not be separately paid for. In such an event the fill shall be leveled/finished to the profile as directed at no extra cost.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc, as specified. Actual quantity of consolidated filling or actual quantity or excavation in the borrow pits (less such top soil which has been excavated and not used for filling) whichever is less shall be measured and paid for in cubic meters. The lead, lift etc. shall be as indicated in the schedule of quantities.

Actual quantity of consolidated sand filling shall be measured and paid in cubic meters.

Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the drawings. No payment will be made for excavations/over break beyond payment line specified. Where such measurement is not possible as in the case of strata intermixed with soil, excavated rock shall be properly stacked as directed by Engineer and the volume of rock calculated on the basis of stack measurements after making appropriate allowance for voids. The allowance to be made for voids shall be decided by Engineer and this will not be a subject matter of dispute or appeal.

3.14 Timber Shoring

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as approved by the Engineer. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walings of strong wood at maximum 1.2 meter spacing's, strutted with ballies or as approved by the Engineer. The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by the Engineer. It shall be the responsibility

of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. from collapsing.

Timber shoring may also be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Engineer.

The withdrawal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacings shall be subject to the approval of the Engineer. In all other respects, the Specifications for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut. If however,

Engineer directs any timbering to be left-in, keeping in mind the type of construction or any other factor, Contractor shall be paid for at the scheduled item rate for such left-in timbering.

3.15 Measurement

Unless separately provided for in the Schedule of Quantities, the actual effective area of shored faces as approved by Engineer shall be measured in sq.m. The area of planking embedded in the bed/sides of excavation will not be considered, nor the area supporting inclined struts in case of large pits/open excavation. All planks, boards, walings, verticals, struts, props and all other materials required for shoring and subsequent safe dismantling and removal shall be included in the quoted unit rates.

3.16 Dewatering

The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Engineer, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any tests necessary at the site with the approval of the Engineer to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Engineer. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a buildup of water in the opinion of the Engineer obstructs the progress of the work, leads to insanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Engineer, to be large, a well point system- single stage or multistage, shall be adopted. The Contractor shall submit to the Engineer, details of his well point system including the stages, the spacing, number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval. Unless separately provided for in the Schedule of prices, the cost of dewatering shall be included in the item rate for excavation.

3.17 Measurement

Unless separately provided for in the Schedule of quantities, dewatering is deemed to have been included in the unit rates quoted for excavation. If separately provided for, the unit of measurement shall be as indicated in the Schedule of Quantities.

3.18 Rain Water Drainage

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Engineer.

3.19 Earthen Embankment Construction

3.19.1 Scope

These Specifications shall apply to the construction of embankments including sub grades, earthen shoulders and miscellaneous backfills with approved materials obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrade, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross-sections shown on the Drawings or as directed by the Engineer.

3.19.2 Physical Requirements of materials

The materials used in embankments, sub grades, earthen shoulders and miscellaneous backfills shall be soil, murum, gravel, a mixture of those or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/subgrade.

The following types of material shall be considered unsuitable for embankment:

Materials from swamps, marshes and bogs.
Peat, log, stump and perishable material any soil that classifies as OL, OI, OH or Pt in accordance with IS: 1498.
Materials susceptible to spontaneous combustion.
Materials in frozen conditions.
Clay having liquid limit exceeding 70 and plasticity index exceeding 45 and

Materials with salts resulting in leaching in the embankment.

Expansive clay exhibiting marked swell and shrinkage properties (“free swelling index” exceeding 50 percent when tested as per IS: 2720 Part 40) shall not be used as a fill material. Where expansive

clay with acceptable "free swelling index" value is used as a fill material, subgrade and top 500 mm portion of the embankment just below subgrade shall be non-expansive in nature.

Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO3) per litre when tested in accordance with BS: 1377 Test 10, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works.

Materials with a total sulphate content (expressed as SO3) exceeding 0.5 percent by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited within 500 mm, or other distances described in the Contract, of metallic items forming part of the Permanent Works.

The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in the subgrade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

Ordinarily, only the materials satisfying the density requirements given in Table I shall be employed for the construction of the embankment and the subgrade.

Table-I. Density Requirements of Embankment and Subgrade Materials

Sr.	Type of Work	Maximum laboratory dry unit weight when tested as per IS: 2270 (Part 8)
1.	Embankments up to 3 meters height, not subjected to extensive flooding.	Not less than 15.2 kN/cum.
2.	Embankments exceeding 3 meters height or embankments of any height subject to long periods of inundation	Not less than 16.0 kN/cum.
3.	Sub grades and earthen shoulders / verges / backfill	Not less than 17.5 kN/cum.

Notes: This Table is not applicable for lightweight fill material e.g. cinder, fly ash etc.

The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.

The material to be used in subgrade should also satisfy design CBR at the dry unit weight applicable as per Table-II.

3.19.3 General requirements of materials

The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

Borrow Materials

Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer / the Engineer, arrangement for locating the source of supply of material for embankment and subgrade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plants is operating at the place of deposition.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising there from.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or siting of temporary buildings or structures.

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the subgrade material when compacted to the density requirements as in Table II shall yield the design CBR value of the subgrade.

Table-II. Compaction Requirements for Embankment and Subgrade

Sr	Type of work/ material	Relative compaction as percentage of max. laboratory dry density as per IS: 2720 (Part 8)
1.	Subgrade and earthen shoulders	Not less than 97
2.	Embankment	Not less than 95
3.	Expansive Clays	
	a) Subgrade and 500 mm portion just below the subgrade	Not allowed
	b)Remaining portion of embankment	Not less than 90

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

A graph of density plotted against moisture content from which each of the values in (1) above of maximum dry density and optimum moisture content were determined.

The Dry density-moisture content-CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

3.19.4 Construction Operations for Embankments

Setting out

After the site has been cleared to Section-1, the work shall be set out. The limits of embankment/subgrade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment / subgrade shall be built sufficiently wider than the design dimension so that surplus materials may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

Dewatering

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair / restore it to original condition or compensate the damage at his own cost. If the embankment is to be constructed under Water, Clause 3.19.5 shall apply.

Stripping and Storing topsoil

In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed

areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

Compacting ground supporting Embankment / Subgrade

When necessary, the original ground shall be leveled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table-II.

In case where the difference between the subgrade level (top of the subgrade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 percent relative compaction with respect to the dry density as given in Table-I, the ground shall be loosened up to a level 0.5 m below the subgrade level, watered and compacted in layers in accordance with Clause 3.19.4 to not less than 97 percent of dry density as given in Table-II.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or subgrade work shall not proceed until the foundations of embankments/subgrade have been inspected by the Engineer for satisfactory condition and approved.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which embankment is to be built has any of the material types specified in Clause 3.19.2, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

Spreading material in layers and bringing to appropriate moisture content

The embankment and subgrade material shall be spread in layers of uniform thickness not exceeding 200 mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per Clause 3.19.4. The motor grader blade shall have hydraulic control

suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table-II and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such construction, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surfaces but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, discing or harrowing until and uniform moisture content is obtained throughout the depth of the layer.

If the; material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the; moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS: 2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1% above to 2% below the optimum moisture content determined in accordance with IS: 2720 (Part 7) or IS: 2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the subgrade.

Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 3.19.5 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

Compaction

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Smooth wheeled, vibratory, pneumatic tyred, sheepfoot or pad foot rollers, etc., of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of vibratory roller of 80 to 100 kN static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction.

The Contractor shall demonstrate the efficiency of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table-I. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 of MORTH Specifications for Roads and Bridge Works (V Revision) and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture / density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identified to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurement reveal any soft areas in the embankment / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

Drainage

The surface of the embankment / subgrade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

Repairing of damages caused by rain / spillage of water

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 3.19.5. If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery / equipment for the purpose.

Finishing operations

Finishing operations shall include the work of shaping and dressing the shoulders / verge / roadbed and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the Drawings or as directed by the Engineer subject to the surface tolerance described in **Clause 902** of MORTH Specifications for Roads and Bridge Works (V Revision). Both the upper and lower ends of

the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with **Clause 3.20**. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of **Clause 3.21**.

When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

3.19.5 Construction of Embankment and Subgrade under Special Conditions

Earthwork for widening existing road embankment

When an existing embankment and / or subgrade is to be widened and its slope are steeper than 1 vertical on 4 horizontal, continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment / subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment / subgrade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers / plate compactors / power rammers of any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

Earthwork for embankment and subgrade to be placed against sloping ground:

Where an embankment / subgrade is to be placed against sloping ground, the latter shall be

appropriately benched or ploughed / scarified as required in **Clause 3.19.5** before placing the embankment / subgrade material. Extra earthwork involved in benching or due to ploughing / scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall subsoil drains at the lowest point shall be provided as per the Drawings, before the fill is placed against sloping ground.

Earthwork over existing road surface:

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

If the existing road surface is of granular or bituminous type and lies within 1 m of the new subgrade level, the same shall be scarified to a depth of 50 mm or more if specified, so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.

If the existing road surface is of cement concrete type and lies within 1 m of the new subgrade level the same shall be removed completely.

If the level difference between the existing road surface and the new formation level is more than 1 m, the existing surface shall be permitted to stay in place without any modification.

Embankment and subgrade around structures:

To avoid interference with the construction of abutments, wing walls or return walls of culvert / bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures up to a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days.

The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in Appendix 6 of IRC:78 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respect of the type of material, the extent of backfill, its laying and compaction etc. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of **Table-II.**

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in **Clause 2502** of MORTH Specifications for Roads and Bridge Works (V Revision) unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

Construction of Embankment over Ground Incapable of Supporting Construction Equipment:

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geosynthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract will be the

responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 3.19.4.

Embankment construction under water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall consist of graded, hard durable particles with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

Earthwork for high embankment

In the case of high embankments, the Contractor shall normally use the material from the specified borrow area. In case he desires to use different material for his own convenience, he shall have to carry out necessary soil investigations and redesign the high embankment at his own cost. The Contractor shall then furnish the soil test data and design of high embankment for approval of the Engineer, who reserve the right to accept or reject it.

If necessary, stage construction of fills and any controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the Contract. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below formation level, the Contractor shall remove the unacceptable material and dispose it as per direction of the Engineer. He shall then bring the resultant level up to formation level with acceptable material.

Settlement period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wingwall, retaining wall, footings, etc., or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the Contract or as directed by the Engineer.

3.19.6 Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and / or subgrade without the prior permission of the Engineer. Any damage arising out of such use shall, however, be made good by the Contractor at his own expense as directed by the Engineer.

3.19.7 Surface Finish and Quality Control of Work

The surface finish of construction of subgrade shall conform to the requirements of Clause 902 of MORTH Specifications for Roads and Bridge Works (V Revision). Control on the quality of materials and works shall be exercised in accordance with Clause 903 of MORTH Specifications for Roads and Bridge Works (V Revision).

3.19.8 Subgrade Strength

It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR.

Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on undisturbed samples cut out from the compacted subgrade in CBR mould fitted with cutting shoe or on remoulded samples, compacted to the field density at the field moisture content.

3.19.9

Measurements for Payment

Earth embankment/subgrade construction shall be measured separately by taking cross sections at intervals in the original position before the work starts and after its completion and computing the volumes of earthwork in cubic metres by the method of average end areas.

The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cum. of suitable material brought to site from road and drainage excavation forms one cum. of compared fill and all bulking or shrinkage shall be ignored.

Construction of embankment under water shall be measured in cum.

Construction of high embankment with specified material and in specified manner shall be measured in cum.

Stripping including storing and reapplication of topsoil shall be measured in cum.

Work involving loosening and recompacting of ground supporting embankment / subgrade shall be measured in cum.

Removal of unsuitable material at embankment / subgrade foundation and replacement with suitable material shall be measured in cum.

Scarifying existing granular / bituminous road surface shall be measured in square metres.

Dismantling and removal of existing cement concrete pavement shall measured vide Clause 202.6 of MORTH Specifications for Roads and Bridge Works (V Revision).

Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cum.

3.19.10 Rates

The Contract unit rates for the items of embankment and subgrade construction shall be payment in full for carrying out the required operations including full compensation for:

Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided otherwise in the Contract;

Setting out;

Compacting ground supporting embankment / subgrade except where removal and replacement of unsuitable material or loosening and recompacting is involved;

Scarifying or cutting continuous horizontal benches 300 mm wide on side slopes of existing embankment and subgrade as applicable;

Cost of watering or drying of material in borrow areas and / or embankment and subgrade during construction as required.

Spreading in layers bringing to appropriate moisture content and compacting to Specification requirements;

Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners;

Restricted working at sites of structures;

Working on narrow width of embankment and subgrade;

Excavation in all soils from borrow pits / designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the Contract;

All labour, materials, tools, equipment and incidentals necessary to complete the work to the Specifications, Dewatering and Keeping the embankment / completed formation free of water. In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the Contract for construction of embankment and subgrade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

The Contract unit rate for the items of stripping and storing topsoil and of reapplication of topsoil shall include full compensation for all the necessary operations including all lifts, but leads up to 1000 m.

The Contract unit rate for loosening and recompacting the loosened materials at subgrade shall include full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

The Contract unit rate for scarifying existing granular / bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. This will also comprise of handling, salvaging, stacking and disposing of the dismantled materials within all lifts and up to a lead of 1000 m or as otherwise specified.

Clause 202.7 of MORTH Specifications for Roads and Bridge Works (V Revision) shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.

The Contract unit rate for providing and laying filters material behind abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.

Clause 3.19.5 shall apply as regards Contract unit rate for construction of embankment under water.

Clause 3.19.5 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

3.20 Soil Erosion and Sedimentation Control

3.20.1 Scope

This work shall consist of measures as shown on plans or as directed by the Engineer to control soil erosion, sedimentation and water pollution, through use of berms, dikes, sediment basins, fibre mats, mulches, grasses, slope drains, and other devices.

3.20.2 Materials

All materials shall meet commercial grade standards and shall be approved by the Engineer before being used in the work.

3.20.3 Construction Operations

Prior to the start of the relevant construction, the Contractor shall submit to the Engineer for approval his schedules for carrying out temporary and permanent erosion / sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment / subgrade construction, bridges and other structures across water course, pavement courses and shoulders. He shall also submit for approval his proposed method of erosion / sedimentation control on service road and borrowpits and his plan for disposal of waste materials. Work shall not be started until the erosion / sedimentation control schedules and methods of operations for the applicable construction have been approved by the Engineer.

The surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations shall be limited to the extent practicable. The Contractor may be directed to provide immediate permanent or temporary erosion and sedimentation control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other water courses, lakes, reservoirs etc. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches,

fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Cut and fill slopes shall be seeded and turfed as required on the plans.

The Contractor shall be required to incorporated all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion / sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices, but may neither be foreseen during design stage nor associated with permanent control features on the Project.

Where erosion or sedimentation is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion or sedimentation control features can follow immediately thereafter if the project conditions permit; otherwise temporary erosion or sedimentation control measure may be required between successive construction stages. Under no conditions shall a large surface area of erodible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the Engineer.

The Engineer may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such permanent erosion, sedimentation and pollution control measures, in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion / sedimentation control measures shall be taken immediately to the extent feasible and justified.

In the event temporary erosion, sedimentation and pollution control measures become necessary due to the Contractor's negligence, carelessness or failure to install permanent controls as a part of the work as scheduled or ordered by the Engineer, these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work required, which is not attributed to the Contractor's

negligence, carelessness of failure to install permanent controls, will be performed as ordered by the Engineer.

Temporary erosion, sedimentation and pollution control may include construction work outside the right-of-way where such work is necessary as result of road construction such as borrow pit operations, service roads and equipment storage sites.

The temporary erosion, sedimentation and pollution control features installed by the Contractor shall be acceptably maintained by him till these are needed, unless otherwise agreed by the Engineer.

3.20.4 Measurements for Payment

The soil erosion, sedimentation and pollution control works will be measured in terms of units specified in the Bill of Quantities for the respective items.

3.20.5 Rates

The contract unit rate for different items of soil erosion, sedimentation and pollution control works shall be payment in full for carrying out all required operations including full compensation for all labour, tools, equipment and incidents to complete the works to the Specifications.

3.21 Turfing with Sods

3.21.1 Scope

This work shall consist of furnishing and laying of the live sod of perennial turf forming grass on embankment slopes, verges (earthen shoulders) or other locations as directed by the Engineer. Unless otherwise specified, the work shall be taken up as soon as possible following construction of the embankment, provided the season is favorable for establishment of the sod.

3.21.2 Materials

The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be use, and shall be practically free from weeds or other undesirable matter. At the

time the sod is cut, the grass on the sod shall have a length of approximately 50 mm and the sod shall have freed of debris.

Thickness of the sod shall be as uniform as possible, with some 50-80 mm or so of soil covering the grass roots depending on the nature of the sod, so that practically all the dense root system of the grasses is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width, not less than about 250 mm X 300 mm in size but not so large that it is inconvenient to handle and transport these without damage. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather shall be watered before lifting to ensure its vitality and prevent the dropping of the soil in handling.

3.21.3 Construction Operations for Turfing with Sods

Preparation of earth bed

The area to be sodded shall have been previously constructed to the required slope and cross section. Soil on the area shall be loosened, freed of all stones larger than 50 mm size, sticks, stumps and any undesirable foreign matter, and brought to a reasonably fine granular texture to a depth of not less than 25 mm for receiving the sod.

Where required, topsoil shall be spread over the slopes. Prior to placing the topsoil, the slopes shall be scarified to a depth which, after settlement, will provide the required nominal depth shown on the plans. Spreading shall not be done when the ground is excessively wet.

Following soil preparation and top soiling, where required, fertilizer and ground limestone when specified shall be spread uniformly at the rate indicated on the plans. After spreading, the materials are incorporated in the soil by discing or other means to the depths shown on the plans.

Placing the sods

The prepared sod bed shall be moistened to the loosened depth, if not already sufficiently moist, and the sod shall be placed thereon within approximately 24 hours after the same had been cut. Each sod strip shall be laid edge to edge and such that the joints caused by abutting ends are staggered. Every strip, after it is snugly placed against the strips already in position, shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil.

On side slopes steeper than 2 (horizontal) to 1 (vertical), the laying of sods shall be started from bottom upwards. At points where water may flow over a sodded area, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth placed over this followed by its through compaction.

Staking the sods

Where the side slope is 2 (horizontal) to 1 (vertical) or steeper and the distance along the slope is more than 2 m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000 mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

Top dressing

After the sods have been laid in position, the surface shall be cleaned of loose sod, excess soil and other foreign material. Thereafter, a thin layer of topsoil shall be scattered over the surface of top dressing and the area thoroughly moistened by sprinkling with water.

Watering and maintenance

The sods shall be watered by the Contractor for a period of at least four weeks after laying. Watering shall be so done as to avoid erosion and prevent damage to sodded areas by wheels of water tanks.

The Contractor shall erect necessary warning signs and barriers, repair or replace sodded areas failing to show uniform growth of grass or damaged by his operations and shall otherwise maintain the sod at his cost until final acceptance.

Measurement for Payment

Turfing with sods shall be measured as finished work in square metres.

Rate

The Contract unit rate for turfing with sods shall mean payment in full for carrying out all the required operations explained above including compensation for:

Furnishing all the materials to be incorporated in the Works with all leads and lifts; and

All labour, tools, equipment and incidental to complete the work in accordance with these Specifications.

3.22 Seeding and Mulching

3.22.1 Scope

This shall consist of preparing slopes, placing topsoil, furnishing all seeds, commercial or organic fertilizers and mulching materials, providing jute netting and placing and incorporation the same on embankment slopes or other locations designated by the Engineer or shown in the Contract documents.

3.22.2 Materials

Seeds

The seeds shall be approved quality and type suitable for the soil on which these are to be applied, and shall have acceptable purity and germination to requirements set down by the Engineer.

Fertilizer

This shall consist of standard commercial materials and conform to the grade specified. Organic manure shall be fully purified organic matter such as cow dung.

Mulching materials

This shall consist of straw, hay wood shavings or sawdust and shall be delivered dry. They shall be reasonably free of weed seed and such foreign materials as may detract from their effectiveness as mulch or be injurious to the plant growth.

Topsoil

Topsoil shall not be obtained from an area known to have noxious weeds growing in it. If treated with herbicides or sterilents, it shall be got tested by appropriate agricultural authority to determine the residual in the soil. Topsoil shall be contain less than 2 per cent and more than 12 per cent organic matter.

Bituminous Emulsion

A suitable grade of bituminous cutback or emulsion used as a tie down for mulch shall be as described in the Contract document or as desired by the Engineer. Emulsified bitumen shall not contain any solvent or diluting agent toxic to plant life.

Netting

Jute netting shall be undyed jute yam woven into a uniform open weave with approximate 2.5 cm square openings. Geonetting shall be made of uniformly extruded rectangular mesh having mesh opening of 2 cm x 2 cm. The colour may be black or green. It shall weigh not less than 3.8 kg per 1000 sq. m.

3.22.3 Seeding Operations

Seed-bed Preparation

The area to be seeded shall be brought to the required slope and cross-section by filling, reshaping eroded areas and refinishing slopes, median etc. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans, unless otherwise approved by the Engineer. The see-bed preparation shall consist of eliminating all live plants by suitable means using agricultural implements. All stones 150 mm in smallest dimension and larger shall be removed. The soil shall be excavated on the contour to a depth of 100 mm. All clods large than 25 mm in diameter shall be crushed and packed. Where necessary, water shall then be applied. All topsoil shall be compacted unless otherwise specified or approved by the Engineer. Compaction shall be by slope compactor, cleated tractor or similar equipment approved by the Engineer. Equipment shall be so designed and constructed as to produce a uniform rough textured surface ready for seeding and mulching and which will bond the topsoil to the underlying material. The entire area shall be covered by a minimum of 4 passes or 2 round trips of the roller or approved equipment.

Fertilizer application

Fertilizer to the required quantities shall be spread and thoroughly incorporated into the soil surface as a part of the seed-bed preparation.

Planting of seeds

All seeds shall be planted uniformly at the approved rate. Immediately after sowing, the area shall be raked, dragged or otherwise treated so as to cover the seeds to a depth of 6 mm. The operation of seed sowing shall not be performed when the ground is muddy or when the soil or weather conditions would otherwise prevent proper soil preparation and subsequent operations.

Soil Moisture and Watering requirements

Soil moisture shall exist throughout the zone from 25 mm to at least 125 mm below the surface at the

time of planting. Watering off the seeded areas shall be carried out as determined by the Engineer.

Mulching, Applying Bituminous Emulsion and Jute Netting / Geonetting

Within 24 hours of seeding, mulching material mixed with organic manure shall be placed so as to form a continuous, unbroken cover of approximate uniform thickness of 25 mm using an acceptable mechanical blower. Mulching material shall be held in place and made resistant to being blown away by suitable means approved by the Engineer. When called for in the Contract documents, mulch material shall be anchored in place with bituminous emulsion applied at the rate of 2300 liters per hectare. Any mulch disturbed or displaced following application shall be removed, reseeded and remulched as specified. Jute netting / Geonetting shall be unrolled and placed parallel to the flow of water immediately following the bringing, to finished grade, the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, they shall overlap a minimum of 100 mm. Jute netting / Geonetting shall be held in place by approved wire staples, pins, spikes or wooden stakes driven vertically into the soil

Maintenance

The Contractor shall maintain all seeded and mulched areas until final acceptance. Maintenance shall include protection of traffic by approved warning signs or barricades and repairing any areas damaged following the seeding and mulching operations. If mulched areas become damaged, the area shall be reshaped and then seeded and mulched again as originally specified.

Measurement for payment

Seeding and mulching shall be measured as finished work in square metres.

Rate

The Contract unit rate for seeding and mulching shall be payment in full for carrying out all the required operations including full compensation for all materials, labour, tools and incidentals.

Preparation and Surface Treatment of Formation

Preparation and surface treatment of the formation, that is top of the subgrade, shall be carried out only after completion of any specified subgrade drainage and unless otherwise agreed by the Engineer,

immediately prior to laying the sub-base or the road base where no sub-base is required. The sequence of operations shall be as follows:

All surfaces below carriageway, lay byes, footways and hard shoulders shall, after reinstatement of any soft areas to the required Specifications be well cleaned and freed of mud and slurry.

The surface shall be compacted by 4 passes of a smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

The formation shall, wherever necessary, be regulated and trimmed to the requirements with motor grader.

The trimmed formation shall be rolled by one pass of smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

Where the completed formation is not immediately covered with sub base or road base material, its moisture content shall be maintained to prevent cracking in the formation by suitable measures as approved by the Engineer. The entire work of surface treatment of formation shall be deemed as incidental to the work of sub-base / base course to be provided on the subgrade and as such no extra payment shall be made for the same.

Works to be Kept Free of Water

The Contractor shall arrange for the rapid dispersal of water collected / accumulated on the earthwork or completed formation during construction or on the existing roadway or which enters the earthwork or any other item of work from any source, and where practicable, the water shall be discharged into the permanent outfall of the drainage system. The arrangement shall be made in respect of all earthwork including excavation for pipe trenches, foundations or cuttings.

The Contractor shall provide, where necessary, temporary water courses, ditches, drains, pumping or other means for maintaining the earthwork free from water. Such provisions shall include carrying out the work of forming the cut sections and embankments in such manner that their surfaces have at all times a sufficient

minimum crossfall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

The works involved in keeping the earthwork or any other item of works free of water shall be deemed as incidental to the respective item of work and as such no separate payment shall be made for the same.

3.23 Gabion Embankment

Gabions are compartmented rectangular containers made of heavily galvanised steel wire, filled with stones, the gabion becomes a large, flexible and permeable building block. Gabions comprises of welded wire mesh panels accurately cut to size with heavy section wire spirals used for interconnecting the edges. The meshes and spirals are pre galvanized with zinc coating of 450 gram per m2. Gabion shall be confirming to ASTM-A974 (Standard Specifications for Welded Wire Fabric Gabions and Gabion Mattresses).

Welded wire mesh is a prefabricated reinforcement consisting of a series of parallel longitudinal wires with accurate spacing welded to cross wires at the required spacing. The welding of the wires is achieved by electric resistance welding with solid state electronic control and all the spacing are controlled by the automatic mechanism of high reliability. There is no foreign metal added at the joint. The intersecting wires are actually fused into a homogeneous section thereby ensuring permanency of spacing and alignment in either direction. Welded Mesh shall be as per IS:4948 (latest Version). Gabions shall be fabricated in such a manner that the sides, ends, lids and diaphragms can be assembled at the construction site into a rectangular basket of the specified sizes. The basket shall be a single unit construction. In other words, the base, lid and sides shall be woven into a single unit. The ends and diaphragms shall be connected to the base section of the gabion. This connection should be such that strength and flexibility at the point of intersection is at least equal to that of the mesh. Gabion shall be provided minimum 0.5m below ground level.

The boulders shall be hard and shall not deteriorate under water. The section shall be worked out considering 10% porosity with a depth of 1m below the ground to a top level. The slope can be upto 1:0.25. boulder size shall not exceed 200mm.

3.24 Site Filling

3.24.1 Sand fill

Sandy fill shall be deposited to bring the grade level to the desired elevation after compaction of fill. Sandy fill shall be carried out in one of the following methods as detailed in the drawings:

Compaction of sandy fill by flooding the area shall be carried out where so specified. In this case, Contractor should ensure that the fill material is not washed away. This work shall be carried out as directed by Engineer.

Sandy fill shall be compacted where so specified by 12 tonne vibrating rollers. The fill material shall be compacted to the required density.

If the density of fill or use of rollers for compaction is not specified, Contractor shall ensure necessary compaction by the passage of trucks, carrying the fill material over the deposited fill in such a way that the entire fill area is covered. This will reasonably compact the sand fill and will be accepted by Engineer. However, Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200mm in thickness.

3.24.2 Soil fill

Approved soil fill consisting of ordinary soil, murrum, soil containing gravel, shingle, etc. shall be deposited in layers not exceeding 200mm. Contractor should ensure that all clods of earth are broken down to a size not larger than 100mm.

Where density of fill or use of rollers is not specified, the fill shall be carried out as specified above.

Where specified, the required density to fill shall be obtained by proper compaction.

3.24.3 Measurement

Measurement shall be made on the basis of Clause 3.13.

End of Section-3

SECTION – 4

CONCRETE AND ALLIED WORKS

SECTION - 4

CONCRETE AND ALLIED WORKS

4.1 Applicable Codes

4.1.1 Materials

1) IS: 269 Specification for Ordinary Portland cement.
2) IS: 455 Specification for Portland slag cement.
3) IS: 1489 Specification for Portland-pozzolana cement (Part 1&2).
4) IS: 12330 Specification for sulphate resisting Portland cement.
5) IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.
6) IS: 432 Specification for mild steel and medium (tensile steel bars and hard-drawn steel) wires for concrete reinforcement. (Part 1 and 2)
7) IS: 1786 Specification for high strength deformed steel bars and wires for concrete reinforcement.
8) IS: 1566 Specification for hard-drawn steel wire fabric for concrete reinforcement.
9) IS: 9103 Specification for admixtures for concrete.
10) IS: 2645 Specification for integral cement water- proofing compounds.
11) IS: 4990 Specification for plywood for concrete shuttering work.

4.1.2 Material Testing

1) IS: 650 Specification for standard sand for testing of cement
2) IS: 2430 Methods for sampling of aggregates for concrete.
3) IS.2386 Methods of test for aggregates for concrete (Parts 1 to 8)
4) IS: 3025 Methods of sampling and test (physical and chemical) for water used in industry.
5) IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
6) IS: 4032 Method chemical analysis of hydraulic cement.
7) IS: 6925 Methods of test for determination of water soluble chlorides in concrete admixtures.

4.1.3 Material Storage

1) IS: 4082 Recommendations on stacking and storing of construction materials at site.

4.1.4 Concrete Mix Design

1) IS: 10262 Recommended guidelines for concrete mix design.
2) SP: 23 (S&T) Handbook on Concrete Mixes.

4.1.5 Concrete Testing

1) IS: 1199 Method of sampling and analysis of concrete.
2) IS: 516 Method of test for strength of concrete.
3) IS: 9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
4) IS: 8142 Method of test for determining setting time of concrete by penetration resistance.
5) IS: 9284 Method of test for abrasion resistance of concrete.
6) IS: 2770 Methods of testing bond in reinforced concrete.

4.1.6 Equipments

1) IS: 1791 Specification for batch type concrete mixers.
2) IS: 2438 Specification for roller pan mixer.
3) IS: 4925 Specification for concrete batching and mixing plant.
4) IS: 5892 Specification for concrete transit mixer and agitator.
5) IS: 7242 Specification for concrete spreaders.
6) IS: 2505 General Requirements for concrete vibrators: Immersion type.
7) IS: 2506 General Requirements for screed board concrete vibrators.
8) IS: 2514 Specification for concrete vibrating tables.
9) IS: 3366 Specification for pan vibrators.
10) IS: 4656 Specification for form vibrators for concrete.
11) IS: 11993 Code of practice for use of screed board concrete vibrators.

12) IS: 7251 Specification for concrete finishers.

13) IS: 2722 Specification for portable swing weigh batchers for concrete (single and double bucket type).

14) IS: 2750 S Specification for steel scaffoldings.

4.1.7 Codes of Practice

1) IS: 456 Code of practice for plain and reinforced concrete.

2) IS: 457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

3) IS: 3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)

4) IS: 3935 Code of practice for composite construction.

5) IS: 2204 Code of practice for construction of reinforced concrete shell roof.

6) IS: 2210 Criteria for the design of reinforced concrete shell structures and folded plates.

7) IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement.

8) IS: 5525 Recommendation for detailing of reinforcement in reinforced concrete works.

9) IS: 2911 Code of practice for Design and construction of Pile foundations. (Part 1 to 4)

10) IS: 9417 Specification for welding cold worked bars for reinforced concrete construction.

11) IS: 3558 Code of practice for use of immersion vibrators for consolidating concrete.

12) IS: 3414 Code of practice for design and installation of joints in buildings.

13) IS: 4326 Code of practice for earthquake resistant design and construction of building.

14) IS: 4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)

15) IS: 2571 Code of practice for laying insitu cement concrete flooring.

16) IS: 7861 Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.

17) IRC: 112 Code of practice for Concrete Road Bridges.

18) IRC: 78 Standard Specifications and Code of Practice for Road Bridges.

18) IRC: 21 Standard Specifications and Code of Practice for Road Bridges.

19) IS: 919 Recommendation for limits and fits for engineering.

20) IS: 1597 Construction of Stone Masonry (Part I & II)

4.1.8 Construction Safety

1) IS: 3696 Safety code for scaffolds and ladders. (Parts 1 & 2)
2) IS: 7969 Safety code for handling and storage of building materials.
3) IS: 8989 Safety code for erection of concrete framed structures.

4.1.9 Measurement

1) IS: 1200 Method of measurement of building and Engineering works
2) IS: 3385 Code of practice for measurement of Civil Engineering works

4.2 General

The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer's approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials which do not conform to the Specifications shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Engineer and after establishing their performance suitability based on previous data, experience or tests.

4.3 Materials

4.3.1 Cement

Unless otherwise called for by the Engineer, cement shall be ordinary Portland cement conforming to IS: 269. Where Portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Engineer. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangement shall be approved by the Engineer. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery. Storage of cement shall be as per standard practices.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Engineer and until the results of such tests are found satisfactory, it shall not be used in any work.

4.3.2 Aggregates (General)

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS: 383.

Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Engineer. Aggregate source shall be approved by BWSSB.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed. Plums shall not constitute more than 20% by volume of the concrete.

The natural/ river sand to be used shall be clean, sieved and of good quality. As far as possible natural/ river sand shall be used. Whenever there is scarcity of natural/ river sand, manufactured sand / crushed sand can be used to a maximum extent of 50% of total sand quantity for plastering items and 100% for concrete items. The certification by the concerned Executive Engineer, Quality Control is mandatory for usage of artificial/ manufactured sand.

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be piled in layers not exceeding 1.20 m in height to prevent coning or segregation. Each layer shall cover the entire area of stockpile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

Foreign Material Limitations in Fine Aggregate

S. No.	**Foreign Material**	**Percentage by weight**	
		Uncrushed	**Crushed**
1	Material finer than 75 micron BIS	3.0	15.0
2	Shale	1.0	-
3	Coal & Lignite	1.0	1.0
4	Clay lumps	-	1.0
Total		**5.0**	**17.0**

Grading of Sand for Fine Aggregate

BIS:Sieve Designation	**Grading Zone I**	**Grading Zone II**	**Grading Zone III**	**Grading Zone IV**
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-90	90-100
600 µm	15-34	35-59	60-79	80-100

Grading of Sand for Coarse Aggregate

BIS: Sieve Size	**Percentage passing for single sized aggregate of normal size**					**Percentage passing for graded aggregate of normal size**			
	40 mm	**20 mm**	**16 mm**	**12.5 mm**	**10 mm**	**40 mm**	**20 mm**	**16 mm**	**12.5 mm**
63 mm	100	-	-	-	-	-	-	-	-
40 mm	85-100	100	-	-	-	95-100	100	-	-
20 mm	0-20	85-100	100	-	-	30-70	95-100	100	100
16 mm	-	-	85-100	100	-	-	-	90-100	-
12.5 mm	-	-	-	85-100	100	-	-	-	90-100
10 mm	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36 mm	-	-	-	-	0-5	-	-	-	-

Foreign Material Limitations in Coarse Aggregate

S. No.	Foreign Material	Percentage by weight	
		Uncrushed	**Crushed**
1	Material finer than 75 micron BIS Sieve	3.0	3.0
2	Coal and Lignite	1.0	1.0
3	Clay Lumps	1.0	1.0
4	Soft Fragments	3.0	-
Total		**8.0**	**5.0**

4.3.3 Water

Water used for both mixing and curing shall conform to IS: 456. Potable waters are generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used. Contractor shall also use treated water being sold by BWSSB, to end exploitation of ground water.

4.3.4 Reinforcement

In general, reinforcement shall conform to HYSD-CRS-500 and other reinforcement bars shall conform to IS: 432 or IS: 1786 and welded wire fabric to IS: 1566 as shown or specified on the drawing.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirty, dust, or any other substance that will destroy or reduce bond.

4.3.5 Admixtures

Accelerating, retarding, water-reducing and air entraining admixtures shall conform to IS: 9103 and integral water proofing admixtures to IS: 2645.

Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Engineer. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedment.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

4.3.5.1 Air Entraining Agents

Neutralized Vinson resin or other approved air in the concrete mix agents shall conform to the requirements of ASTM standard 6.260; Air Entraining Admixtures for Concrete. The recommended total air content of the concrete is 4% + 1%. The method of measuring air content shall be as per IS: 1199.

4.3.5.2 Water Reducing Admixtures

Water reducing lignosulfonate admixture may be added in quantities approved by the Engineer. The admixtures shall be added in the form of a solution.

4.3.5.3 Retarding Admixtures

Retarding agents may be added to the concrete mix in quantities approved by the Engineer.

4.3.5.4 Water Proofing Agent

Water proofing agents shall conform to IS: 2645.

4.3.5.5 Other Admixtures

The Engineer may at his discretion allow the contractor to use any other admixture in the concrete.

4.4 Wastage

Wastage allowance for cement and steel and higher rolling margin for steel shall be considered in the item rate and no extra payment shall become payable to the Contractor on any account.

4.5 Samples and Tests

All materials used for the works shall be tested before use. Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by the Engineer samples shall also be got tested by the Contractor in a laboratory approved by the Engineer at no extra cost to Employer. Sampling and testing shall be as per IS: 2386 under the supervision of the Engineer. Water to be used shall be tested to comply with requirements of IS: 456.

The Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

4.6 Storing of Materials

All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

The Contractor will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by the Engineer. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

The Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

4.7 Concrete

4.7.1 General

Concrete grade shall be as designated on drawings. In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq.mm as per IS:456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M10 and M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

The grades of concrete to be used are noted on the drawings. In addition, the following table shall apply unless specified otherwise.

Structure	**Grade of Concrete**	**Max. Aggregate Size**
1. All Liquid retaining structures / Wet wells/ Bridges/ Piles/ Pile caps	M30	20 mm
2. Sewage Pumping Stations/ Buildings		
(a) for foundation raft	M25	20 mm
(b) for walls, columns, floor beams, circular floor slab	M25	20 mm
(c) for beams, slabs etc.	M25	20 mm
3. Valve chambers		
(a) for foundation raft	M25	20 mm
(b) walls, columns	M25	20 mm
(c) for slabs, beams, etc.	M25	20 mm
4. Anchor blocks/ Thrust blocks/ Antiflotation blocks	M20	40 mm
5. Saddles	M25	20 mm

6. Pipeline embankment, grade slab, ramps, footings under walls, SW drain coping etc	M15	20 mm
7. Bridges Foundation of piers and abutments Piers and abutments with wing walls Hammer head of pipes	 M30 M30 M30	 20 mm 20 mm 20 mm
8. Causeway	M20	20 mm
9. Manholes	M30	20 mm

4.7.2 Controlled Concrete

All concrete in the works shall be "Controlled Concrete" as defined in IS: 456 except for M-10 for which normal mix concrete shall be used. Whether reinforced or otherwise, all concrete works to be carried out under this specification shall be divided into the following classifications:

Note: It shall be very clearly understood that whenever the grade of concrete such as M-20, etc. is specified it shall be contractor's responsibility to ensure the minimum crushing strength stipulated for the respective grade of concrete is obtained at works.

Class	**Preliminary Test N/mm^2**		**Works Test N/mm^2**		**Maximum size of aggregate mm**	**Locations for use**
	At 7 Days	**At 28 Days**	**At 7 Days**	**At 28 Days**		
M30	25.0	38.0	20.0	30.0	40 or 20	As indicated in the specifications or as required
M25	22.0	32.0	17.0	25.0	40 or 20	-do-
M15	13.5	20.0	10.0	15.0	40 or 20	-do-

4.7.3 Design Mix Concrete

4.7.3.1 Mix Design & Testing

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in water tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result based on SP23 Fig 37 of minimum cement paste volume in concrete for durability.

The minimum cement content for Design Mix Concrete shall be as per Table-5 of IS: 456 and for Pile foundations as per IS: 2911 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/Cu.m of Concrete
M20	320
M25	360
M30	400

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the Contractor in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the Contractor.

The Contractor shall submit details of the source of all material and the proposed quantities of each ingredient per cubic metre of fully compacted concrete. The Contractor shall then make trial mixes for each class of concrete using the same Contractor's Equipment and the same materials as are proposed for

the Permanent Works. The Contractor shall give 24 hours notice of such trials to enable the Engineer's Representative to attend. For each trial mix, three separate batches of concrete shall be made by the Contractor and will be tested at 28 days all in accordance with IS: 516. Such trial mixes shall not be the first batch through the plant in any one sequence of concrete production.

The Contractor shall not commence concreting in the Permanent Works until details of trial mixes and test results for each class of concrete have been submitted to and approved by the Engineer.

Unless otherwise specified, only medium graded fine aggregate shall be used
A trial mix design will be approved by the Engineer with respect to strength if the average compressive strength of the nine cubes so tested is more than the target means strength appropriate to the grade of concrete.

For concrete of Grade 30 and over the Contractor shall cast two sample wall panels 48 hours apart. Each shall be cast in two equal lifts to form a wall panel having one horizontal construction joint formed in the manner proposed by the Contractor for the Works. The top surface of the second lift shall have a Type U3 finish. The panels shall not be touched up after stripping. The panels shall be 300 mm thick and 1.5 m long by 1.5 m high. The Contractor shall not commence concreting in the Permanent Works until the test panels have been approved by Engineer.

The Contractor shall not alter the approved mix proportions or the approved source of supply of any of the ingredients without having previously obtained the approval of the Engineer.
During production, the Engineer may require trial mixes to be made before a substantial change is made in the materials or in the proportions of the materials to be used.
It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish to the Engineer at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456 as follows:

Grade of Concrete	Minimum Compressive Strength N/sq.mm at 7 days	Specified Characteristic Compressive Strength N/sq.mm at 28 days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Engineer is given below:

4.7.3.2 Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer, alternatively the compacting factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of form work and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests

4.7.3.3 Workmanship

All workmanship shall be according to the latest relevant standards. Before starting a pour the contractor shall obtain the approval of the Engineer in a "Pour Card" maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability of water per unit of cement, number of test cubes to be taken, finishing to be done and any admixture to be added etc

Structure/Member	Slump in millimeters	
	Maximum	Minimum
Reinforced foundation walls and footings	75	40
Plain footings, caissons and substructure walls	75	40
Slabs, Beams and reinforced walls	100	50

Pump & miscellaneous Equipment Foundation	75	40
Building columns	100	40
Pavements	50	40
Heavy mass construction	50	40

Note: All concreting done for water retaining structures shall have a minimum slump value of 80 mm and maximum of 100 mm

4.7.3.4 Batching & Mixing of Concrete

It is expected that batching plants of minimum 30 m^3 capacity, with two silos and pumps for placing concrete shall be used. Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by the Engineer shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Engineer. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456.

4.7.4 Nominal Mix Concrete

4.7.4.1. *Mix Design & Testing*

Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS: 456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per

Table 9 of IS: 456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

4.7.4.2. *Batching & Mixing of Concrete*

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only, using whole bags of cement.

4.8 Formwork

Formwork shall be all inclusive not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the Engineer, the drawings and calculations for the design of the formwork shall be submitted to the Engineer for approval.

Formwork shall be designed to fulfill the following requirements:

1. Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

2. Made of suitable materials.

3. Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

4. Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

5. Capable of easily striking without shock, disturbance or damage to the concrete.

6. Soffit forms capable of imparting a camber if required.

7. Soffit forms and supports capable of being left in position if required.

8. Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete. design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left insitu shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

All corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size, except where specified in the drawings.

Forms for substructure may be omitted when, in the opinion of the Engineer, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the Engineer, than that required as per drawing to compensate for irregularities in excavation.

The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the Engineer. The Contractor shall temporarily and securely fix items to be cast (embedment's/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirements:

Development of adequate concrete strength;
Permissible deflection at time of striking form work;
Curing procedure employed - its efficiency and effectiveness;
Subsequent surface treatment to be done;
Prevention of thermal cracking at re-entrant angles;
Ambient temperatures; and
Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Under normal circumstances (generally where temperatures are above $20^{o}C$) forms may be struck after expiry of the time period given in IS: 456 unless approved otherwise by the Engineer. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the Engineer. It is the

Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

4.9 Removal of Formwork

Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the loads likely to be imposed on the concrete and shall in any case be not less than the periods, shown in Table below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement of the Engineer, remove the formwork at the earlier times listed below provided that the props are left in position.

Table 12

Position of Formwork	**Days for Striking**
Walls	1
Sides of beams and columns	1
Slabs (Drops left under)	3
Props to slabs (span not exceeding 4.5m)	7
Props to slabs (span exceeding 4.5 m)	14
Beams soffits (props left under)	21

Not withstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Striking shall be done slowly with utmost care to avoid damage to projections and without shock or vibration, by gently easing the wedges. If after removing the form work it is found that timber has been embedded in the concrete. It shall be removed and made good as specified earlier.

Reinforced temporary openings shall be provided, as directed by the Engineer, to facilitate removal of formwork which otherwise may be inaccessible.

The rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours not later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade beams will not be permitted.

4.10 Technical Specifications for Sheet Piling

4.10.1 General

Sheet piling is a form of driven piling using interlocking sheets of steel to obtain a continuous barrier in the ground. The main application of sheet pile is in retaining walls erected for the purpose of excavation to enable permanent works to proceed. Normally vibrating hammer/ impact hammer, crane and crawler drilling are to be used to establish sheet piles. The work shall be done as per BOQ provisions. The work shall include supply, installation and subsequent removal of all miscellaneous steel shapes, plates and connecting hardware when required to attach the sheeting to an existing substructure unit and/or facilitate stage construction.

All initial banking has to be formed at contractor's own cost for taking the machinery to drive the sheet piles. The area shall be filled driving of steel sheet piles with pit sand for leveling the ground.

Piles shall be driven, true to plumb and alignment. Hammer for sheet pile driving shall be drop hammer, steam hammer, air hammer, diesel hammer or vibratory hammer. Sheet pile driving shall commence initially with minimum impact of hammer, which can be increased later after ensuring that the piles are being driven vertically through the interlocking grooves along with designed alignment. The sheet piles are to be driven with batten welded at suitable intervals. The Steel Sheet Pile may be lifted at single point

4.10.2 Applicable Code

All work shall be carried out strictly in accordance with the Technical Specifications, unless otherwise approved by Engineer in writing. The Indian Standard Codes applicable to this section shall include but not limited to the following.

4.10.2.1INDIAN STANDARDS (IS CODES)

IS 2314:1986 Specification for steel sheet piling sections (first revision)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M (2000) General Requirements for Rolled Structural Steel Bars,

Plates, Shapes, and Sheet Piling

ASTM A 328/A 328M (200) Steel Sheet Piling

ASTM A 572/A 572M (200) High-Strength Low-Alloy Columbium-Vanadium

Structural Steel

ASTM A 690/A 690M (1994) High-Strength Low-Alloy Steel H-Piles and

Sheet Piling for Use in Marine Environments

ASTM A 857/A 857M (1997el) Steel Sheet Piling, Cold Formed, Light Gage.

4.10.3 Transportation

The Contractor shall set up, in accordance with the construction schedule make all the necessary arrangements for hauling of all materials for the steel sheet pile driving so that all the materials will be available for immediate use whenever required:

a) All the steel sheet piles shall be delivered intact at the site without causing any permanent distortion in the member or injury or deformation at joints.

b) Care shall be taken in handling such materials as tie-rods to avoid damage to the thread and shop coat painting.

c) Handling of such long members as walling shall be carried out in the same way as for the steel sheet piles.

4.10.4 Storage

a) Storage space for steel sheet piles shall be reasonably leveled and compacted. The site so selected should be got approved by the ENGINEER.

b) Steel sheet piles shall be stacked in such a way as to avoid strain or distortion in the materials.

c) Steel sheet piles shall be stacked up in such tiers as each consisting of not more than 3 piles, and between each tier wooden sleepers shall be inserted at intervals not exceeding 4m. Total height of stack shall not exceed 2m.

d) Tie-rods and accessories shall be sorted, stacked in accordance with their diameters and shall be stored under cover and not be directly exposed to weather.

e) The Contractor shall be responsible for safe handling, mobilization & demobilization and storage of piles and other materials. The rate for sheet pile driving shall include the cost for handling and storage of piles and other accessories, forming driving pit, formation and removal of earthen bund if required, all other requisites for successful driving of sheet pile.

4.10.5 Cutting of Sheet Pile

a) Cutting of steel sheet piles shall be done by means of a gas cutting device.

b) Steel sheet piles to be cut shall be free from curve and warp, and securely clamped on a level work table for cutting.

c) Use of a special jig is desirable to minimize deformation due to cutting

d) Whatever method is used in cutting, a certain degree of deformation is bound to occur. If the deformation is less than 40mm, it can be set right by hammering or by heat treatment to the deformed segment. If the deformation exceeds the above range, mechanical correction by means of jacks and press shall be made.

4.10.6 Sheet Pile Welding

a) Arc welding shall be adopted for steel sheet pile work.

b) Only skilled welders approved by the ENGINEER shall be engaged for the work.

c) Welding equipment shall be AC rectifiers / arc-welding unit. Welding rods shall be those conforming to the relevant IS or equivalent and subject to prior approval of ENGINEER.

d) If any welding is rejected by the ENGINEER, the Contractor shall perform the welding again by cutting off at the weld at his cost. All the costs thereof shall be borne by the Contractor.

4.10.7 Materials

Metal sheet piling material shall be conforming to IS:2314 or equivalent ASTM standards. The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed. Sheet piling [including special abricated sections] shall be [full-length] sections of the dimensions as shown in the drawing. Sheet piling shall be provided with standard pulling holes.

Metal plates, shapes, bolts, nuts, rivets, and other appurtenant fabrication and installation materials shall conform to manufacturer's standards and to the requirements specified in the respective sheet piling.

4.10.8 Extraction of Rejected Sheet Pile:

If the pile driving work has not been done to the specification, the Contractor shall extract the rejected pile. The extraction shall be such as to avoid damages to the adjoining piles, other structures and installations. Cost of extraction and replacement shall be borne by the Contractor.

4.10.9 Construction

The Contractor shall verify locations of all underground utilities before driving any sheet piling. Any disturbance or damage to existing structures, utilities or other property, caused by the Contractor's operation, shall be repaired by the Contractor in a manner satisfactory to the Engineer at no additional cost to the Department. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor's approved design. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor's approved design. The sheet piling shall be driven, as a minimum, to the tip elevation(s) specified, prior to commencing any related excavation. If unable to reach the minimum tip elevation, the adequacy of the sheet piling design will require re-evaluation by the PMC/ Owner prior to allowing excavation adjacent to the sheet piling in question. The Contractor shall not excavate below the maximum excavation line shown on the plans without the prior permission of the Engineer. The sheet piling shall remain in place until the Engineer determines it is no longer required.

The sheet piling shall be removed and take away from site by the Contractor when directed by the Engineer. When allowed, the Contractor may elect to cut off a portion of the sheet piling leaving the rest in place. The remaining piling shall be a minimum of 12 in. (300 mm) below the finished grade or as directed by the Engineer. Removed sheet piling becomes the property of the Contractor. When an obstruction is encountered, the Contractor shall notify the Engineer and upon concurrence of the Engineer, the Contractor shall begin working to break up, push aside, or remove the obstruction. An obstruction shall be defined as any object (such as but not limited to, boulders, logs, old foundations etc.) where its presence was not obvious or specifically noted on the plans prior to bidding, that cannot be driven through or around with normal driving procedures, but requires additional excavation or other procedures to remove or miss the obstruction.

The following are the installation procedure:-

1 The alignment of sheet pile wall shall be correctly set up for the approval of the ENGINEER before commencing the sheet pile driving.

2 Guide frames and stakes shall be installed correctly and secured properly to ensure driving of piles on the centre line.

3 Steel sheet pile driving shall be performed by one of the following methods.

a) In driving single pile one by one, special care shall be exercised to keep each pile penetrating in strictly vertical direction.

b) In driving a group of piles (about 20 pieces simultaneously) a guide frame shall be used to keep them in a straight alignment, and in the initial stage all the piles shall be driven to a depth just enough to enable them to stand in positions. Then one or two pieces on both ends shall be driven down first, followed by the intermediate piles which shall be driven alternately in several stages to final level.

4 Prior to starting pile driving, the Contractor shall submit the driving method and time schedule for approval of the ENGINEER and in accordance with the sequence approved by the ENGINEER. The piles shall be driven vertically in the specified positions.

5 Pile driving:

a) Sheet pile driving shall commence initially with minimum impact of hammer and increased later after ensuring that the piles are being driven vertically in designed alignment.

b) Pile shall be driven with cap and cushion on top of the pile for protection against the impact of drop hammer.

c) Lengthening of pile, if required, shall be done by welding additional piece on to the top of pile already driven. The joints shall be as strong as the normal section of the pile.

d) In case interlocks of piles with adjacent ones are found loosened or dislocated during or after driving, such piles shall be pulled out and replaced with new ones or redone otherwise in accordance with instructions of the ENGINEER.

e) The Contractor shall take every step to ensure safety and to prevent accident while handling and driving piles. If any deviation from specified lines, fractured top, deficient or excessive penetration is observed during pile driving, the driving shall be suspended to take corrective measures as directed by the ENGINEER.

f) Necessary data and logs such as of the number of blows, length of penetration etc. during sheet pile driving shall be made and submitted in duplicate to the ENGINEER at no extra cost. Format of driving log shall be got approved by ENGINEER prior to commencement of driving sheet piles.

6 Reformed steel sheet piles:

a) Reformed steel sheet piles shall be of three types, namely corner sheet pile, junction sheet pile and wedge sheet pile.

b) Corner sheet piles are used where centre line for driving turns to form an angle, and joined by welding to the sheet pile wall that has changed its direction.

c) Junction sheet piles are those to be used where two walls of sheet piles meet at right angle forming a T junction, and where the sizes of sheet pile change along the same line.

d) Wedge sheet piles are used to make up for the deviation of piles from the plumb line caused during driving. This type of pile is characterized by its wedge like shape, tapering downward to the tip.

e) Reformed steel sheet piles as mentioned above shall as a rule is manufactured in a factory. If it becomes inevitable to fabricate them in the field at site, the Contractor shall provide equipment and manufacturing means equivalent to those of the regular factory production and have close supervision and control over driving.

f) If the Contractor finds it necessary to use the reformed steel sheet piles, he shall obtain approval of the ENGINEER for the use, and fabricate the same at his own cost in accordance with the instructions of the ENGINEER.

4.10.10 Payment for Steel Sheet Piling

It may be noted that the measurement shall be taken for one side of the trench only and the Contractor shall be paid for one side only even though sheet pilling work is provided for both sides trench in accordance with the Contract drawings or as directed by the Engineer. The unit rate for steel sheet pile driving shall include the costs of material, transportation, driving and incidental costs towards replacement of the damaged steel sheet piles. The cost will also include the cost of waling and accessories.

4.11 Reinforcement Workmanship

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5^{o}C. Local warming may be permitted if steel is kept below 100^{o} C.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by the Engineer.
Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Engineer.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Engineer prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.
Substitution of reinforcement, laps/splices not shown on drawing shall be subject to Engineer's approval.

4.12 Tolerances

Tolerance is a specified permissible variation from lines, grade or dimensions given in drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Tolerance for formed and concrete dimensions shall be as per IS:456 unless specified otherwise.

4.12.1 Tolerances for R.C. Buildings

Variation from the Plumb

(i) In the lines and surfaces of columns, piers, walls and in arrises 5 mm per 2.5 m or 25 mm, whichever is less.

(ii) For exposed corner columns and other conspicuous lines

In any bay or 5 m maximum	-	5 mm
In 10 m or more	-	10 mm

Variation from the level or from the grades indicated on the drawings

(i) In slab soffits, ceilings, beam soffits, and in arises

In 2.5 m	-	5 mm
In any bay or 5 m maximum	-	10 mm
In 10 m or more	-	15 mm

(ii) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines :

In any bay or 5 m maximum	-	5 mm
In 10 m or more	-	10 mm

Variation of the linear building lines from established position in plan and related position of columns, wall and partitions :

In any bay or 5 m maximum - 10 mm

In 10 m or more - 20 mm

Variation in the sizes and locations of sleeves, openings in walls and floors – 5 mm except in the case anchor bolts.

Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus - 5 mm

Plus - 10 mm

Footings

(i) Variation in dimension in plan

Minus - 5 mm

Plus - 50 mm

(ii) Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm

(iii) Reduction in thickness

Minus - 5% of specified thickness subject to a maximum of 50 mm

Variation in steps

(i) In a flight of stairs

Rise - 3 mm

Tread - 5 mm

(ii) In consecutive steps

Rise - 1.5 mm

Tread - 3.0 mm

4.12.2 Tolerances in other structures

All structures

(i) Variation of the construction linear outline from established position in plan

In 5 m - 10 mm

In 10 m or more - 15 mm

(ii) Variations of dimensions to individual structure features from established positions

In 20 m or more - 25 mm

In buried construction - 50 mm

(iii) Variation from plumb, from specified batter or from curved surfaces of all structures

In 2.5 m - 10 mm

In 5 m - 15 mm

In 10 m or more - 25 mm

In buried construction - Twice the above amounts

(iv) Variation from level or grade indicated on drawings in slab, beams, soffits, horizontal grooves and visible arises.

In 2.5 m - 5 mm

In 7.5 m or more - 10 mm

In buried construction - Twice the above amounts

(iv) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members

Minus - 5 mm

Plus - 10 mm

(vi) Variation in the thickness of slabs, walls, arch sections and similar members

Minus - 5 mm

Plus - 10 mm

Footing for columns, piers, walls, buttresses and similar members

(i) Variation of dimension in plan

Minus - 10 mm

Plus - 50 mm

(ii) Misplacement or eccentricity

2% footing width in the direction of misplacement but not more than 50 mm

(iii) Reduction in thickness

5% of specified thickness subject to a maximum of 50 mm.

Tolerance in fixing anchor bolts shall be as follows:

(i) Anchor bolts without sleeves	:	1.5 mm in plan
(ii) Anchor bolts with sleeves	:	5.0 mm in elevation
- for bolts upto and including 28 mm dia	:	5 mm in all directions
- for bolts 32 mm dia and above	:	3 mm in all directions
(iii) Embedded parts	:	5 mm in all directions

4.12.3 Tolerances in Formwork:

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below:

(i)	Deviation from specified dimensions of cross section of columns and beams	- 6 mm + 12 mm
(ii)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels)	
	- Dimension in plan	- 12 mm + 50 mm
	- Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
	- Thickness	± 0.05 times the specified thickness

4.13 Preparation Prior to Concrete Placement

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by the Engineer. Contractor shall maintain separate Pour Card for each pour as per the format enclosed.

4.14 Transporting, Placing and Compacting Concrete

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m.
Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

1. Continuously between construction joints and pre- determined abutments.
2. Without disturbance to forms or reinforcement.
3. Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
4. Without dropping in a manner that could cause segregation or shock.
5. In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
6. Do not place if the workability is such that full compaction cannot be achieved.
7. Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
8. If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
9. Ensure that there is no damage or displacement to sheet membranes.
10. Record the time and location of placing structural concrete.
11. Cover blocks of required size depending on the cover of the reinforcement as mentioned in the drawings should be prepared in 1:3 cement mortar with fine aggregates.

12. The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed. Top layer should be rough and with key for further extension of work.
13. Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, as specified in the IS, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures.
14. Vibrators shall conform to BIS specifications. Type of vibrator to be used shall depend on the structures where concrete is to be placed.
15. Bleeding or free water on top of concrete being deposited into the forms, shall be the cause to stop the concrete pour and the conditions causing this defect corrected before any further Concreting is resumed.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork.

Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers.

Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Engineer. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Engineer. Concrete shall be protected against damage until final acceptance.

4.15 Mass Concrete Works

Sequence of pouring for mass concrete works shall be as approved by the Engineer. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

4.16 Curing

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

1. Premature drying out, particularly by solar radiation and wind
2. Leaching out by rain and flowing water
3. Rapid cooling during the first few days after placing
4. High internal thermal gradients
5. Low temperature or frost
6. Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless approved otherwise by the Engineer, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessain or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is approved to be used by the Engineer, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the Engineer before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

4.17 Construction Joints and Keys

Construction joints will be as shown on the drawing or as approved by the Engineer. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting

becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Engineer.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Engineer.

As soon as the exposed concrete has sufficiently hardened, the surface of the joint shall be water jetted or brushed with a stiff brush to expose the larger aggregate without being disturbed. Roughening of the surface by chipping or hacking will not generally be approved. Before placing fresh concrete against a construction joint all loose material shall be removed and the surface sluiced with water until it is perfectly clean, thereafter all ponded water should be removed.

When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

4.18 Movement Joints

1. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The contractor shall comply with the instructions of manufacturers of proprietary jointing materials and shall, if required by the Engineer, demonstrate that the jointing materials can be applied satisfactorily.
2. The surface of set concrete in a movement joint shall, as shown on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved preformed joint filler.
3. 3. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer's instructions. At all caulked joints, the face

of the caulking strip and a width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound.

4.19 Foundation Bedding

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Engineer. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

4.20 Finishes

4.20.1 General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

4.20.2 Surface Finish Type F1

The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

4.20.3 Surface Finish Type F2

The appearance shall be that of a smooth dense, well- compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

4.20.4 Surface Finish Type F3

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, arises, airholes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

4.20.5 Unformed Surfaces

Finishes to unformed surfaces of concrete shall be classified as U1, U2, and U3, 'spaded or bonded concrete'. Where the class of finish is not specified the concrete shall be finished to Class U1.

Class U1 finish is the first stage for Class U2 and U3 finishes and for a bonded concrete surface. Class U1 finish shall be a levelled and screeded, uniform plain or ridged finish which (unless it is being converted to Class U2, U3, or bonded concrete) shall not be disturbed in any way after the initial set and during the period of curing, surplus concrete being struck off immediately after compaction.

Where a bonded concrete surface is specified, the laitance shall be removed from the Class U1 finished surface and the aggregate exposed while the concrete is still green.
A spaded finish shall be a surface free from voids and brought to a reasonably uniform appearance by the use of shovels as it is placed in the Works.

Class U2 finish shall be a wood float finish. Floating shall be done after the initial set of the concrete has taken place and the surface has hardened sufficiently. The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

Class U3 finish shall be a hard smooth steel-trowelled finish. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from

being worked into the surface. The surfaces shall be trowelled under firm pressure and left free from trowel marks.

The addition of dry cement, mortar or water shall not be permitted during any of the above operations.

4.20.6 Integral Cement Finish on Concrete Floor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Engineer shall be supplied and used as recommended by the manufacturer.

4.21 Repair and Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, and holes left by form bolts etc. shall be inspected by the Engineer who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Engineer.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar with approved bonding agent or by applying epoxy. The decision of the Engineer as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Engineer.

All the form bolt repairs and delayed repairs shall be carried out using a proportion of white cement in repair mix to the approval of the Engineer, so as to match the colour of the surrounding area.

4.22 Vacuum Dewatering of Slabs

Where specified floor slabs, either grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturers recommendation. The equipment to be used shall be subject to the Engineer's approval.

4.23 Hot Weather Requirements

Concreting during hot weather shall be carried out as per IS: 7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 33^{o} C at the time of placement of fresh concrete.

Where directed by the Engineer, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

4.24 Liquid Retaining Structures

The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be Type F2. All such structures shall be hydro-tested.

The Contractor shall make all arrangements for hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the Engineer. All such rectification shall be done by the Contractor to the entire satisfaction of the Employer/Engineer at no extra cost to the Employer.

4.25 Testing Concrete Structures for Leakage

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the Engineer, as described below:

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are buried and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The Engineer shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/segment of the structure shall be tested individually.
For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period

the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

4.26 Optional Tests

If the Engineer is not satisfied with the results of the tests under Clause 4.5 or otherwise considers that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Engineer, as per relevant IS Codes. Contractor shall have to pay for these tests.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the Engineer reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The Engineer also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer.

If the structure is certified as failed by Engineer, the cost of the test and subsequent dismantling/reconstruction shall be borne by the Contractor.

The quoted unit rates/prices of concrete shall be deemed to provide for all tests mentioned above.

4.27 Acceptance Criteria

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

a) Properties of constituent materials;
b) Characteristic compressive strength;
c) Specified mix proportions;
d) Minimum cement content;
e) Maximum free-water/cement ratio;
f) Workability
g) Temperature of fresh concrete;
h) Density of fully compacted concrete;

i) Cover to embedded steel;

j) Curing;

k) Tolerances in dimensions;

l) Tolerances in levels;

m) Durability;

n) Surface finishes;

o) Special requirements such as;

- i) Water tightness
- ii) Resistance to aggressive chemicals
- iii) Resistance to freezing and thawing
- iv) Very high strength
- v) Improved fire resistance
- vi) Wear resistance
- vii) Resistance to early thermal cracking

The Engineer's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Contractor.

For work not accepted, the Engineer may review and decide whether remedial measures are feasible so as to render the work acceptable. The Engineer shall in that case direct the Contractor to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the Contractor by the Employer for executing the remedial measures.

4.28 Mode of Measurement and Payment

The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items as leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the Schedule of Quantities. No extra claim shall also be entertained due to change in the number, position and/or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding etc. All these factors should be taken into consideration while quoting the unit rates. Unless provided for in the Schedule of Quantities the rates shall also include fixing inserts in all concrete work, whenever required.

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 of a sq.m. and 0.010 cu.m where concrete is measured in cu.metres. Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slabs/beams.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by Engineer shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rate for reinforcement shall include all wastages, binding wires, chairs, spacer bars etc. For which no separate payment shall be made.

Where the formwork is paid for separately, it shall be very clearly understood the payment for formwork is inclusive of formwork, shuttering, shoring, propping scaffolding etc. Only the net area of concrete formed (shuttered) shall be measured for payment.

4.29 Waterstops

4.29.1 Material

The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS: 8543.

a)	Tensile strength	:	11.6 N/mm^2 minimum
b)	Ultimate elongation	:	300% minimum
c)	Tear resistance	:	4.9 N/mm^2 minimum
d)	Stiffness in flexure	:	2.46 N/mm^2 minimum
e)	Accelerated extraction		
	i) Tensile strength	:	10.50 N/mm^2 minimum
	ii) Ultimate elongation	:	250% minimum
(f)	Effect of Alkali	:	7 days
	i) Weight increase	:	0.10% maximum
	ii Weight decrease	:	0.10% maximum
	iii) Hardness change	:	± 5 points
(g)	Effect of Alkali	:	28 days
	i) Weight increase	:	0.40% maximum
	ii) Weight decrease	:	0.30% maximum
	iii) Dimension change	:	±1%

PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use.

Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.

PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Engineer before procurement for incorporation in the works.

4.29.2 Workmanship

Waterstops shall be cleaned before placing them in position Oil or grease shall be removed thoroughly using water and suitable detergents.

Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard

junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Particular care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets.

4.29.3 Measurement

Measurement shall be in running metres correct to two places of decimal. No separate payment shall be made for joints or intersection pieces.

4.30 Curing, Protecting, Repairing and Finishing

4.30.1 Curing

All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated coverings of sacking, canvas, hessain or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

4.30.1.1 Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened. Water

shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

4.30.1.2 Continuous Spraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose, sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer.

4.30.1.3 Alternate Curing Methods

Whenever in the judgment of the Engineer, it is necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during curing period. For curing of concrete in sidewalks, floors, flat roofs of other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

4.30.1.4 Curing Compound

Surface coating type-curing compounds shall be used only by special permission of Engineer. Curing compounds shall be liquid type white pigmented, confirming to US Bureau of Reclamation specification. No curing compound shall be used on surfaces where future blending with concrete, water of acid proof membrane or painting is specified.

4.30.1.5 Curing Equipment

All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

4.30.2 `Protecting Fresh Concrete

Fresh concrete shall be protected from defacements and damage due to construction operations by leaving forms in place for an ample period. Newly placed concrete shall be protected by approved means such as

tarpaulins from rain, sun and winds. Steps as approved by the Engineers hall also be taken to protect immature concrete from damage by debris, excessive lading, vibration, abrasion or contact with other materials, etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that the workmen enter the area of freshly placed concrete, the Engineer may require that bridges be placed over the area.

4.30.3 Repair and Replacement of Unsatisfactory Concrete

4.30.3.1General

Immediately after the shuttering is removed, the surface of concrete shall be very carefully inspected and all defective areas attended to by the Engineer may permit patching of the defective areas or reject the concrete unit either partially or entirely. Rejected concrete shall be removed and replaced by the contractor. Holes shall be filled with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm IS sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the Engineer. Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Engineer and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by the Engineer, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surface. Surface irregularities shall be removed by grinding. If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of the Engineer shall be final in this regard. If only patching is necessary, the edges being cut perpendicular to the affected surface or with a small undercut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

4.30.3.2 Use of Epoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of the Engineer. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

4.30.3.3 Method of Repair

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows.

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly protrude of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers, after an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. A steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible. Mortar filling by air pressure (gunniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by the Engineer, to match the shade of the patch with the original concrete.

4.30.4 Curing of Patched Work

The patched area shall be covered immediately with an approved non-staining, water-saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray, or sprinkling for not less than 10 days. All fillings shall be tightly bounded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

4.31 Approval by the Engineer

All materials, procedures and operations used in the repair work shall be subject to the approval of the Engineer.

4.32 Precast Concrete

4.32.1 General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the contract for in situ concrete. Wherever possible, precast units shall be hydraulically pressed. When ready for incorporation in the works, precast units shall be responsible for the accuracy of the level, shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

4.32.2 Striking Forms

Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

4.32.3 Precast Units

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place, contractor shall satisfy the Engineer or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise effect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

4.32.4 Curing

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits.

4.33 Slots, Openings, etc.

4.33.1 General

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions or as directed by Engineer. Short pipes with puddle collar shall be fixed in the sidewall of suction pipes. They shall be supplied at the appropriate time during construction. Any deviation from the approved

drawings shall be made good by contractor at own expense, without damaging any other work. Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

4.34 Grouting

4.34.1 Standard Grout

Grout shall be provided as specified on the drawings. The proportion of Standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All Structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by Engineer. The grout proportions shall be limited as follows:

Use	Grout Thickness	Mix Proportions	W/C Ratio (max)
a) Fluid mix	Under 25mm	One part Portland Cement to one part sand	0.4
b) General mix	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One part Portland Cement to 3 parts of sand	0.53

4.34.2 Non-Shrinking Grout for Equipment Foundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor bolts, other anchoring devices and at locations where ordinary grouts are ineffective due to shrinkage. It shall be composed of a type of expansive hydraulic sheeting binder and select-graded aggregates. It shall have properties as per "*Table 11: Proportions for Non-Shrinking Grout*".

Table 11: Proportions for Non-Shrinking Grout

S. No.	Properties	Values
1	Maximum grain size	6 mm
2	Water % (for 80% flow)	15.17
3	Density of hardened grout	2.27 – 2.30 gm/m
4	Compressive strength N/sqmm	
	Minimum 3 days	23
	7 days	34

Mixing, batching, cleaning, preparation of surface and curing of non-shrinking grout shall be done as per manufacturer's instructions.

4.35 Inspection

a. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer.
b. All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.
c. All concrete shall be protected against damage until final acceptance by the Engineer.

4.36 Clean-up

a. Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.
b. All debris i.e. empty containers, scrap wood, etc., shall be removed to "dump" daily, or as directed by the Engineer.
c. The finished concrete surfaces shall be left in a clean condition satisfactory to the Engineer.

4.37 Preformed Fillers and Joint Sealing Compound

4.37.1 Materials

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS: 1838 (Part I).
Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS: 702. Bitumen primer shall conform to IS: 3384.

Sealants shall be of the following types:

4.37.1.1 Sealant Type A

Sealant Type A shall be a gun grade, non-slumping compound suitable for sealing horizontal, vertical and soffit joints in water retaining structures. It shall be a UK WFBS material approved for unrestricted use in contact with potable water to the full exposure condition of 15000 mm^2/l, and shall not support bacterial growth.
It shall be stable and shall have a low water absorption and good adhesion to concrete.

Hardness (Shore A) : > 12
Transverse Movement Accommodation : ±15%

4.37.1.2 Sealant Type B

Sealant type shall be a gun grade compound, suitable for sealing vertical movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.

Hardness (Shore A) : > 12
Transverse Movement Accommodation : ±12.5%

4.37.1.3 Sealant Type C

Sealant type C shall be similar to Type B above. In addition it shall have been designed for sealing movement and construction joints in hydraulic and water retaining structures and shall be suitable for use in contact with potable water.

Hardness (Shore A) : > 20

Transverse Movement Accommodation : ±12.5%

4.37.1.4 Sealant Type D

Sealant Type D shall be a pourable compound suitable for sealing horizontal movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.

Hardness (Shore A) : > 9

Transverse Movement Accommodation : ±12.5%

4.37.1.5 Sealant Type E

Sealant Type E shall be a cold pouring compound complying with BS 5212, suitable for sealing movement and construction joints in concrete paved areas. It shall be resistant to fuels, oils and hydraulic fluids. It shall be tough, abrasion-resistant and shall not decompose in strong sunlight.

Hardness (Shore A) : > 12

Transverse Movement Accommodation : ±12.5%

4.37.1.6 Approved Sealants

The following approved sealants meet the above specifications.

Sealant Type A, B and C : Thioflex 600 gun grade

Sealant Type : Thioflex 600 pourable grade

Sealant Type E : Colpor 200

The hardness value specified in the above summaries is the Shore A Durometer value at 14 days at 25^{o} C and 50% RH. The specified transverse movement values are based on joints having a width to depth ratio of 1.5: 1.

The Contractor may use the above sealants or ones meeting equivalent or higher specifications.

4.37.2 Workmanship

The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipments. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS:3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

The Contractor shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the Drawings or as agreed with the Engineer.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it.

Joint sealing shall not be commenced without the approval of the Engineer. In reservoir joints the sealer shall be poured after completion of the water tightness test, to the satisfaction of the Engineer.

All joint sealers shall be from an approved manufacturer. The Contractor shall supply the manufacturer's test certificates for each consignment of each type of joint sealant delivered to the Site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure.

Sealants shall be installed in strict accordance with the manufacturer's instructions. De-bonding strip shall be used in conjunction with the sealers as indicated on the Drawings. The de-bonding strip shall be compatible with the joint sealer and shall be resistant to attach from the primer used to bond the sealer to the concrete.

Polysulphide and polyurethane sealants shall not abut bitumen sealers. Surfaces to receive Polysulphide and polyurethane sealants shall be kept free from bituminous paints. All sealants shall be appropriate for the prevailing climatic conditions. Bituminous sealants shall comply with the BS 2499 for Type A1. Polysulphide sealants shall comply with IS 12118.

4.37.3 Measurement

Measurement for the preformed joint filler shall be in sq.m correct to two places of decimal for the specified thickness as per items of work. Measurement for applying the bitumen coat to concrete/masonry surfaces shall be in sq.m correct to two places of decimal. Measurement for the joint sealing compound shall be in running metres correct to two places of decimal for the specified width and thickness as per the items of work. Measurement for the mild steel corner angle and plate shall be by weight as per the items of work.

4.38 Concreting Records

A written record of the concrete works shall be made each day by the Contractor and kept available for inspection by the Engineer. The diary shall contain notes and records of:

1. The names of the Contractor's Engineer who are responsible for the different phases of the concrete work and also the names of their assistants.

2. The temperatures of air, water, cement, aggregate, together with the air humidity and type of weather.

3. Deliveries to the Site of concrete materials (quantity, brand of concrete, etc).

4. Inspections carried out, tests performed, etc. and their results.

5. Times of commencement and completion of different parts of the concrete works and times of erection and striking of forms.

6. Quantity of cement, fine and coarse aggregate and admixture used for each section of work and the number and kind of test samples taken on these ingredients and water.

CONCRETE POUR CARD

CLIENT : DATE : POUR NO. :

PROJECT : STRUCTURE :

Contractor : MAX. AGGREGATE SIZE/ SLUMP :

DRG. NO. : START / COMPLETION TIME : /

CONCRETE GRADE / QUANTITY : MIXING TIME :

/

SL. NO.	ITEM	Contractor's Rep. Sign	Engineer's Sign	Remarks

1.	BEFORECONCRETING	CENTRELINES CHECKED			POUR AUTHORISED SITE ENGINEER
2.		FORMWORK AND STAGING CHECKED FOR ACCURACY, STRENGTH & FINISH			
3.		REINFORCEMENT CHECKED			
4.		COVER TO REINFORCEMENT CHECKED			
5.		VERIFIED TEST CERTIFICATE FOR CEMENT/STEEL	YES / NO	YES / NO	

6.		ADEQUACY OF MATERIALS / EQUIPMENT FOR POUR	YES / NO	YES / NO		
7.		EMBEDDED PART S	CIVIL			
		CHECKED	MECHANICAL			
		(LOCATION & PLUMB)	ELECTRICAL			
8.	SOFFIT(S) & POUR TOP(T) LEVELS CHECKED BEFORE (B) & AFTER (A) FORM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN & IMPORTANT STRUCTURE LIKE T.G. ETC.)		S(B) T(B) S(A) T(A)			
9.	CONSTRUCTION JOINTS LOCATION & TIME (IF NOT AS PER DRAWING)					
10.	CEMENT CONSUMPTION IN KGS.					
11.	NUMBER OF CUBES AND IDENTIFICATION MARKS					

12.	TEST CUBE RESULTS (7 DAYS / 28 DAYS)		
13.	CONCRETE CONDITION ON FORM REMOVAL	V.GOOD/GOOD/FAIR/POOR	

SITE-IN-CHARGE

NOTES : 1. EACH ITEM TO BE CHECKED AND SIGNED BY THE RESPECTIVE ENGINEERS.

2. ITEMS 8 TO 13 (BOTH INCLUSIVE) TO BE FILLED ONLY BY ENGINEER.

3. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, CONSULTANT & SITE OFFICE.

UNDER REMARKS INDICATE DEVIATIONS FROM DWGS. & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURENCES, SUCH AS FAILURE OF EQUIPMENTS, SINKING OF SUPPORTS / PROPS. HEAVY RAINS AFFECTING CONCRETING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATIONS ETC.

End of Section-4

SECTION 5

ROADS AND DRAINS

SECTION 5

ROADS AND DRAINS

5.1 Definitions

The words like Contract, Contractor, Engineer (synonymous with Engineer-in-charge), Drawings, Employer, Government, Works and Work Site used in these Specifications shall be considered to have the meaning as understood from the definitions of these terms given in the General Conditions of Contract.

The following abbreviations shall have the meaning as set forth below:

MORTH	:	Ministry of Road Transport and Highways
IRC	:	Indian Roads Congress
IS	:	Indian Standard published by the Bureau of Indian Standards
GSB	:	Granular Sub Base
WMM	:	Wet Mix Macadam
BM	:	Bituminous Macadam
BC	:	Bituminous Concrete
CBR	:	California Bearing Ratio
AASHTO	:	American Association of State Highway and Transportation Officials
ASTM	:	American Society for Testing and Materials
BS	:	British Standard published by the British Standards Institution

The various elements in the cross-section of a road (STP) referred to in these Specifications are shown in the cross-sections in **Fig. 5-1**.

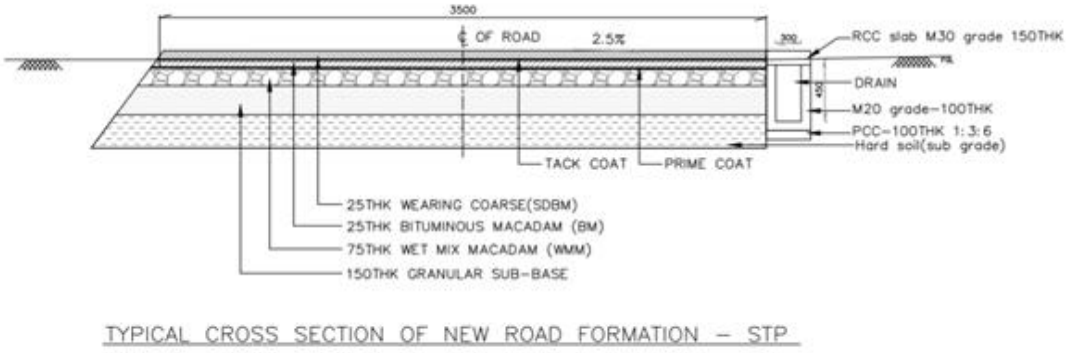

Fig. 5-1: Proposed Typical Cross Section of the Road (STP)

5.2 Applicable Codes and Specifications

The following specifications, standards and codes are referred to in this part.

IS : 460 : Specification for Test sieves

(Parts 1 to 3)

IS : 1077 : Common burnt clay building bricks - Specification

IS : 1124 : Method of test for determination of water absorption, apparent specific gravity and porosity of natural building Aggregates / stones

IS : 1195 : Specification for Bitumen Mastic for Flooring

IS : 1196 : Code of Practice for Laying Bitumen Mastic Flooring

IS : 1834 : Specification for Hot Applied Sealing Compounds for Joints in Concrete

IS : 2386 : Methods of test for aggregates for concrete

(Parts 1 to 8)

IS : 2720 : Method of Test for Soils for determination of Liquid and plastic limit.

(Part 5)

IS : 6241 : Method of test for determination of stripping value of road aggregates.

IRC : 16 : Specification for priming of Base Course with Bituminous Primers.

IRC : 17 : Tentative specification for Single Coat Bituminous Surface Dressing

IRC : 19 : Standard specifications and code of practice for water bound macadam

IRC : 29 : Specification for bituminous concrete (Asphaltic Concrete) for road pavement.

MORTH

Specifications : Ministry of Road Transport and Highways Specifications for Road and Bridge works

SECTION-100 : GENERAL

SECTION-300 : EARTHWORK

SECTION-401 : GRANULAR SUB BASE

SECTION-406 : WET MIX MACADAM

SECTION-504 : BITUMINOUS MACADAM

SECTION-507 : BITUMINOUS CONCRETE

5.3 Road Configuration

The roads shall be installed in layers as per Drawing over the back fill as per concerned sections of MORTH. In Plant premise all the motorable road width is minimum 3.5m.

On laying of Pumping main/sewer lines in the trenches, the roads shall be restored to its original condition in layers as per Drawing over the back fill as per concerned sections of MORTH

Technical specification:

a) Backfill over the water lines / sewer lines to the desired level as per drawing and

specification.

b) Approved soil compacted in layers as per drawing, using soil deposited at site from road cutting and excavation to achieve compaction level Table 300-2 and Section 301 of MORTH Technical specification.

c) Layer of sand / stone dust as per drawing to achieve 97% relative compaction of laboratory dry density to meet requirement of table 300-2 of MORTH specification.

d) Granular Sub base as per section 401 of MORTH specification.

e) Wet mix macadam (WMM) as per section 406 of MORTH specification.

f) Bituminous macadam (BM) as per section 504 of MORTH specification.

g) Bituminous concrete (BC) as per section 507 of MORTH specification.

5.4 Materials

5.4.1 General

All materials shall be obtained from local sources and shall conform to technical specifications and be subject to Engineer's approval prior to use.

5.4.2 Approved soil for Subgrade / Embankment

The materials used in embankments, subgrades and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ subgrade.

The Contractor shall carry out the excavation in such a manner that the acceptable materials are excavated separately for use in backfill/restoration works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

It shall be ensured that the subgrade material when compacted to the density requirements as in **Table 5.1** (As per Table 300-2 of MORTH specification) shall yield the design CBR value of the subgrade.

Table 5.1: Compaction requirement for Subgrade
(As per Table 300-2 of MORTH Specification)

Type of work/material		**Relative compaction as % of max. lab dry density as per IS: 2720 (Part 8)**
1	Subgrade and earthen shoulders	Not less than 97
2	Embankment	Not less than 95

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

i) The values of Maximum Dry Density and Optimum Moisture Content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

iii) The Dry density-moisture content - CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

5.4.3 Granular Sub Base

The material to be used for the work shall be natural sand, murum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The material shall be free from organic or other deleterious constituents and conform to grading-iii given in **Table 5.2: Gradation for coarse graded granular Sub base.** (As per Table 400-1 of MORTH Specifications).

The CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions, which shall be taken as being the density relating to a uniform air, voids content of 5 per cent.

Table 5.2: Gradation for coarse graded granular Sub base.

(As per TABLE 400–1 of MORTH Specification)

IS Sieve	**Percent by weight passing the IS Sieve**		
Designation	**Grading I**	**Grading II**	**Grading III**
75.0 mm	100	-	-
53.0 mm	80-100	100	100
26.5 mm	55 - 90	70-100	55-75
9.50 mm	35-65	50-80	-
4.75 mm	25-55	40-65	10-30
2.36 mm	20-40	30-50	-
0.425 mm	10-15	10-15	-
0.075 mm	<5	<5	<5
CBR Value(Minimum)	30	25	20

Note : The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

5.4.4 Coarse Aggregates

Coarse aggregate, stone chippings shall consist of natural or crushed stone, clean, hard, tough, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt, salt, alkali, vegetable matter, adherent coatings, organic and other objectionable matter, and shall conform to the physical requirements given in **Table 5.3** and **Table 5.4** hereunder, as applicable. Aggregate for bituminous wearing courses shall in addition have good hydrophobic properties i.e. capacity of retaining the film of bituminous material applied to the stone in all weather conditions and especially in wet conditions. Basalt, dolerites are good in this respect; granite, quartzites are comparatively poor.

Table–5.3: Physical Requirements of Coarse Aggregate for Wet Mix Macadam(WM MSl. No	**Test**	**Requirements**	**Test Method**
1.	Los Angeles Abrasion Value* Or Aggregate Impact Value*	40 percent (max.) 30 percent (max.)	IS:2386 (Part – IV) IS:2386 (Part – IV) Or IS:5640***
2.	Flakiness Index **	15 percent (max.)	IS:2386 (Part I)
3.	Combined Flakiness and Elongation Indices**	35 percent (max.)	IS:2386 (Part I)

(*) Aggregate may satisfy requirements of either of two tests.

(**) Requirements of flakiness index shall be enforced only in case of crushed broken stone.

(***) Aggregates like brick, metal, kankar, laterite etc., which get softened in presence of water shall be tested for impact value under wet conditions in accordance with IS: 5640.

Table – 5.4: Physical Requirements of Coarse Aggregates for Dense Bituminous macadam (BM)

(As per Table 500-8 of MORTH Specification)

Sl.No.	Test	Requirements	Test Method
1.	Los Angeles Abrasion Value* Or Aggregate Impact Value*	35 percent (max.) 27 percent (max.)	IS:2386 (Part – IV) IS:2386 (Part –
2.	Combined Flakiness and Elongation Indices (Total) **	35 percent (max.)	IS:2386 (Part I)
3.	Coating and Stripping of Bitumen Aggregate Mix	Min. Retained coating 95%	IS:6241
4.	Water Absorption	2 percent (max.)	IS:2386 (Part-III)
5.	Soundness Loss with Sodium Sulphate – 5 cycles Loss with Magnesium Sulphate – 5 cycles	 12 percent (max.) 18 percent (max.)	 IS:2386 (Part-V)

(*) Aggregate may satisfy requirements of either of two tests

(**) Requirement of flakiness index shall be enforced only in case of crushed broken stone

5.4.5 Murum/Kankar/Gravel

Murum shall contain low plasticity binder material mixed with hard granular particles such as sand and/or gravel. Murum shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free from all impurities. Large lumps shall all be broken at the quarry and murum delivered at site must pass in every direction through a 63 mm ring. Murum shall not contain more than 5% to 8% of fines passing a 75 micron sieve.

Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense and shall not contain particles bigger than 12 mm and more than 10 percent silt.

5.4.6 Sand / Stone Dust

The sand / Stone dust shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorized sand washing machines should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5. The Sand used shall be coarse, sharp, gritty, clean, granular material. Only material passing through 4.75 mm sieve and retained on 75 micron sieve shall be used.

The sand / Stone dust / fine aggregates shall conform to grading requirement in Table 5.5

Table 5.5: Gradation requirement of Sand / Fine aggregates

(As per Table 1000-2 of MORTH Specifications)

IS Sieve Size	Per cent by Weight Passing the Sieve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

Note: When the grading falls outside the limits of any particular grading zone of sieves other than 600-micron IS Sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. However for crushed stone sand, the permissible limit on 150-micron IS Sieve is increased to 20 percent. Reference shall be made to clause: 4.3 of IS: 383.

5.4.7 Bituminous Materials

Bituminous materials shall conform to IS: 73, IS: 215, IS: 217 or IS: 454 as applicable and be of the grade specified.

Table 5.6: Physical requirements of Coarse aggregates for Bituminous concrete (BC).

(As per TABLE 500-16: MORTH specifications)

PROPERTY	TEST	SPECIFICATION	METHOD OF TEST
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve.	IS: 2386 Part I
Particle shape	Flakiness and Elongation Index	Max 30% (Combined)2	IS: 2386 Part I
Strength	Los Angles Abrasion Value or Aggregate Impact Value	Max 30% Max 24%	IS: 2386 Part IV
Polishing	Polished Stone Value	Min 55	BS: 812-114
Durability	Soundness: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS: 2386 Part V

Water Absorption	Water absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures	Minimum retained coating 95%.	IS: 6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

* If the minimum retained Tensile strength test falls below 80%, use of anti-stripping agent is recommended to meet the requirement.

5.5 Earth work

5.5.1 Earthwork in Excavation

In general the excavation shall be in accordance to Specifications specified elsewhere.

Profiles of road excavation shall be laid at 50 m intervals or as specified in Drawings to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.

Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approved by the Engineer in writing. If excavation is done below the specified level or outside the section the Contractor shall be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for the subgrade.

The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections as shown in the drawings or approved by Engineer.

5.5.2 Earthwork in Subgrade

The Subgrade shall be formed of approved soil excavated from road trenches and stacked separately.

Profiles of subgrade shall be set up with stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 metres on straight portions.

Subgrade material shall be placed in successive horizontal layers of 200 mm depth extending to the full width of the Subgrade / trench to allow compaction of the full specified section to 150 mm using mini rollers / tampers / plate vibrators till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content. Before placing the next layer of 200 mm the surface of the underlayer shall be moistured and scarified with pick axes or spades to provide a satisfactory bond with the next layer. The next layer shall also be compacted to 150 mm to the full width of the trench section till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content.

When boulders, broken stones and similar hard materials are mixed up with the embankment materials care shall be taken to see that they are distributed uniformly into the bank and that no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, levelled, and compacted as specified before the succeeding layer is placed. The surface of the embankment shall at all times during construction be maintained at such a cross fall as will shed water and prevent ponding.

If the soil contains less than the optimum moisture, water shall be added to the loose layers of the subgrade to bring the moisture uniformly upto requirement. If the material contains more than the required moisture it shall be allowed to dry until the moisture is reduced to the required extent. The moistured/dried loose layers shall be compacted with a vibratory roller / mini roller / plate vibrator/ tampers to achieve the desired compaction level of 95% of Proctor density.

5.6 Compaction with Sand / stone dust

In order to achieve better compaction and a compacted surface before laying the GSB layer, two layers of sand / stone dust shall be laid and compacted to 150 mm each.

5.7 Preparation of Granular Sub-base (GSB)

Spreading and Compacting: The granular sub base material of **grade-iii** as specified in **Table 5.2: Gradation for coarse graded granular Sub base** (As per Table 400–1 of MORTH Specifications) shall be spread on the prepared sub grade maintaining the required slope and grade during the operation or other means as approved by the Engineer or as per applicable MORTH Specifications. The work shall be done as per Clause 401 MORTH V revision and as per BOQ provisions.

When the sub base material consists of combination of materials mentioned in clause 401.2, mixing shall be done mechanically by the mix in- place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small – sized jobs. The equipment used for mix-in-place construction shall be rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS: 2720 (part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material.

All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re – compacted.

5.8 Wet mix Macadam Course (WMM)

The GSB layer surface over which Wet mix Macadam (WMM) is to be laid shall be prepared to the specified grade and camber and made free of dust and other extraneous material.

Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. WMM. sub-base course of specified thickness shall be provided. The course aggregate for this shall conform to requirements in **Table-5.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM)** (As per Table 400-13 of MORTH Specifications).

Table – 5.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM)

(As per Table 400-13 of MORTH Specifications)

IS Sieve Designation	Percent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95 – 100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-8

5.8.1 Preparation of WMM layer

Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade /sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used so as to achieve the specified slope and grade. The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction: After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable vibratory roller. The speed of the roller shall not exceed 5 km/h. The work shall be done as per Clause 406 MORTH V revision and as per BOQ provisions.

5.9 Primer coat

Primer: The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. Surface of low porosity; such as wet mix macadam. The primer shall be bitumen emulsion.

Primer viscosity: The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in **Table-5.8: Requirement of Viscosity and quantity of Liquid bituminous Primer** (As per Table 500-1 of MORTH Specifications).

Table-5.8: Selection Criteria for Viscosity-Graded (VG) Paving Bitumens based on Climatic conditions (As per Table 500-1 of MORTH Specifications)

Lowest Daily Mean Air Temperature, °C	**Highest Daily Mean Air Temperature, °C**		
	Less than 20 °C	20 to 30 °C	More than 30 °C
More than -10 °C	VG-10	VG-20	VG-30
-10 °C or lower	VG-10	VG-10	VG-20

Providing and applying primer coat with S.S. bitumen emulsion on prepared surface of granular base such as WMM including cleaning of road surface and spraying primer at the rate of 0.60 kg/sqm using mechanical means complete as per specifications The work shall be done as per Clause 502 MORTH V revision and as per BOQ provisions.

Preparation of road surface: The surface to be primed shall be prepared in accordance with Clauses 501.8. and 902 as appropriate. Immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

Application of bituminous primer: The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. The bituminous primer shall be sprayed uniformly in accordance with Clause 501 of MORTH specifications. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Curing of primer and opening to traffic: A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. The work shall be done as per BOQ provisions.

5.10 Tack Coat

Over the primed surface, a tack coat should be applied in accordance with Clause 503 of MORTH Specifications.

The binder used for tack coat shall be bitumen emulsion complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

The tack coat distributor shall be a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of Clauses 501.8 and 902 as appropriate. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in **Table-5.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat** (As per Table 500-5 of MORTH Specifications).

Table-5.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat

(As per Table 500-5 of MORTH Specifications).

Sl No	Type of Surface	Quantity of Liquid bituminous material in Kg per sq.m.area
i)	Normal bituminous surfaces	0.20 to 0.30
iii)	Granular surfaces treated with primer	0.25 to 0.30
iv)	Non bituminous surfaces	0.30 to 0.35

	Cement concrete pavement	

The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback, 50°C to 80°C. The work shall be done as per Clause 503 MORTH V revision and as per BOQ provisions.

5.11 Bituminous Macadam

The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS:73.

Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in **Table-5.10: Composition of Bituminous macadam (BM)** (As per Table 500-7 of MORTH Specification) for the grading specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of Table 500-7.

Table-5.10: Composition of Bituminous macadam (BM)

(As per Table 500-7 of MORTH Specification)

Mix designation Nominal aggregate size Layer thickness	Grading 1 40mm 80 -100mm	Grading 2 19 mm 50 - 75 mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36

2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by weight of total mixture[1]	3.1 - 3.4	3.3 - 3.5
Bitumen grade	35 to 90	35 to 90

5.11.1 Preparation of the Base:

The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with Clause 501.8 and 902.3 as appropriate, or as directed by the Engineer.

5.11.2 Preparation and transportation of the Mixture:

The provisions of Clauses 501.3 and 501.4 shall apply.

5.11.3 Spreading: The provisions of Clauses 501.5.3 shall apply.

5.11.4 Compaction:

Compaction shall be carried out in accordance with the provisions of Clause 501.6 and 501.7. The details of mixing, laying and rolling temperature of BM mix is as indicated in **Table-5.11:** Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree celcius) (As per Table 500-2 of MORTH Specifications)

Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller. The required frequency of testing is defined in Clause 903.

Table-5.11: Mixing, Laying and Rolling Temperatures for Bituminous Mixes

(Degree celcius)

(As per Table 500-2 of MORTH Specifications)

Bitumen Viscosity grade	Bitumen Temperature (°C)	Aggregate Temperature (^{o}C)	Mixed Material Temperature(°C)	Rolling Temperature (^{o}C)	Laying Temperature (^{o}C)
VG-40	160-170	160-170	160-170	100 Min	150 Min
VG-30	150-165	150-170	150-165	90 Min	140 Min
VG-20	145-165	145-170	145-165	85 Min	135 Min
VG-10	140-160	140-165	140-160	80 Min	130 Min

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before opening to any traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately. The work shall be done as per Clause 504 MORTH V revision and as per BOQ provisions.

5.12 Bituminous Concrete

This work shall consist of construction in a single layer of bituminous concrete on a previously prepared Bituminous Macadam (BM) surface. The work shall be done as per Clause 507 MORTH V revision and as per BOQ provisions.

Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table 500-17, for bituminous concrete. The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-17.

Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in **Table-5.12: Composition of Bituminous Concrete** (As per Table 500-17 of MORTH Specifications) and **Table-5.13: Requirement of Bituminous Concrete** (As per Table 500-11: of MORTH Specifications).

Table-5.12: Composition of Bituminous Concrete (As per Table 500-17 of MORTH Specifications)

Grading	**1**	**2**
Nominal aggregate size	19 mm	13.2 mm
Layer Thickness	50 mm	30-40 mm
IS Sieve[1] (mm)	**Cumulative % by weight of total aggregate passing**	
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix[2]	Min 5.2	Min 5.4

Notes: 1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.

2. Determined by the Marshall method.

3. Job mix formula shall be generally as specified in Clause 507.3.3 and the results of tests enumerated in Table 500-19.

Table-5.13: Requirement of Bituminous Concrete

(As per Table 500-11: of MORTH Specifications)

Properties	**Viscosity Grade Paving Bitumen**	**Modified Bitumen**		**Test Method**
		Hot climate	**Cold climate**	
Compaction level	75 blows on each face of specimen			
Minimum stability (kN at 60 ^{o}C)	9.0	12.0	10.0	AASHTO T245
Marshall flow (mm)	2-4	2.5-4	3.5-5	AASHTO T245
Marshall Quotient (Stability/Flow)	2-5	2.5-5		MS-2 and ASTM D2041
% Air voids	3-5			
% Voids Filled with Bitumen (VFB)	65-75			
Coating of aggregate particle	95% minimum			IS: 6241
Tensile strength ratio	80% minimum			AASHTO T283
% Voids in Mineral Aggregate (VMA)	Minimum percent voids in mineral aggregate (VMA) are set out in Table 500-12 of MORTH			

5.12.1 Rolling

Immediately after the spreading of mix it shall be thoroughly compacted by rolling with vibratory rollers moving at a speed not more than 5 km per hour. Rolling shall be continued till the mix is thoroughly compacted to meet the general provisions of clauses 501.6 and 501.7.

5.12.2 Opening to Traffic

Traffic shall be allowed on the road after a lapse of minimum 24 hours, preferably 48 hours after laying as approved by the Employer's Representative.

5.13 Quality Control of Road restoration works

5.13.1 General

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to increase the frequencies of tests as he may deem necessary to satisfy himself that the materials and works comply with the appropriate Specifications.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the approval of the Engineer.

5.13.2 Tests on Earthwork for Embankment and Subgrade Construction

(i) Sand content [IS:2720 (Part IV)]
1-2 tests per 8000 cu. metres of soil or as per MORTH.

(ii) Plasticity Test [IS:2720 (Part V)]
Each type to be tested, 1-2 tests per 8000 cu. metres of soil or as per MORTH.

(iii) Density Test [[IS:2720 (Part VII)].
Each soil type to be tested, 1-2 tests per 8000 cubic metres of soil or as per MORTH.

(iv) Deleterious Content Test [IS:2720 (PartXXVII)]

As and when required by the Engineer.

(v) Moisture Content Test [IS:2720(Part II)]
One test for every 250 cubic metres of soil or as per MORTH.

(vi) CBR Test on materials to be incorporated in the subgrade on soaked/unsoaked samples [IS:2720 (part XVI)]
One test for every 3000 m^3 at least or closer as and when required by the Engineer or as per MORTH.

5.13.3 Compaction control:

Control shall be exercised by taking at least one measurement of density for each 500 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluation a days work on statistical basis. The determination of density shall be in accordance with IS:2720 (part XXVIII). Tests locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 5 as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subject to the condition that the mean dry density equals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc.

However, for earthwork in subgrade and in top 500 mm portion of the embankment below the subgrade, at least one density measurement shall be taken for every 100 square metres of the compacted area provided further `that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

5.13.4 Tests on Granular Sub base (GSB) and Wet mix macadam (WMM) layers

The tests and their frequencies for the different types of bases and sub-base shall be as given in **Table**

Table –5.14: Control Tests and their frequencies for Granular Sub base(GSB) and Wet mix macadam (WMM) layers

Sl.No.	Types of Construction	Test	Frequency***
1.	Granular sub-base	i) Gradation	One test per 200 m^3
		ii) Atterbergs limit	One test per 200 m^3
		iii) Moisture content prior to compaction	One test per 250 m^2
		iv) Density of compacted layer	One test per 500 m^2
		v) Deleterious constituents	As required
		vi) C.B.R	As required
2.	Lime/Cement Stabilised	i) Purity of lime (for lime-soil stabilization	One test for each consignment subject to a minimum of one test per 5 tonnes of lime.
		ii) Lime/Cement content	Regularly, through procedural checks.
		iii) Degree of pulverisation	Periodically as considered necessary.
		iv) CBR test on a set of 3 specimens	As required
		v) Moisture content prior to compaction	One test per 250 m^3.
		vi) Density of compacted layer	One test per 500 m^2
		vii) Deleterious constituents	As required
3	Wet mix Macadam	i) Aggregate Impact Value	One test per 200m^3 of aggregate
		ii) Grading	One test per 100 m^3 of aggregate
		iii) Flakiness Index	One test per 200 m^3 of aggregate

Sl.No.	Types of Construction	Test	Frequency***
		iv) Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 100 m^3

***** Or as per MORTH**

5.13.5 Tests on Bituminous Constructions

The tests and their frequencies for the different types of bituminous works shall be as given in **Table - 5.15** hereunder.

Table – 5.15: Control Tests and their Frequency for Bituminous Works

Sl. No.	Types of Construction	Test	Frequency
1.	Prime Coat/Tack Coat	i) Quality of binder ii) Binder temperature for a application iii) Rate of spread of binder	As Required At regular close intervals Two tests per day

Sl. No.	Types of Construction	Test	Frequency
2	Bituminous macadam (BM) / Bituminous Concrete (BC)	i) Quality of binder	As required
		ii) Aggregate impact value, flakiness index and stripping value of aggregates	One test per 50-100m^3 of aggregate
		iii) Mix-grading	One set of test on individual constituents and mixed aggregates from the dryer for each 100 tonnes of mix subject to a maximum of two sets per plant per day.
		iv) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	At regular close interval.
		v) Stability of mix (vide ASTM:D-1559)	For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value density, and void content, subject to a minimum of two sets being tested per plant per day.
		vi) Binder content and gradation in the mix (Binder content test vide ASTM:D-2172)	One test for each 100 tonnes of mix subject to a minimum of two tests per day per plant.
		vii) Rate of spread of mixed material	Regular control through checks on the weight of mixed material and layer thickness.
		viii) Density of compacted layer	One test per 250 m^2 area

5.14 Slab Culvert

Slab culverts shall be constructed at specified locations of the existing cross drainage works as per drawings, or as directed by the Engineer. The Concrete works specifications for construction of RC slab and the rubble masonry specifications for the supporting rubble walls are given in Section-4 and Section-8 respectively and they shall be followed.

5.14.1 Bitumen at Location of Contact

The Bitumen to be used on the top of the bed concrete at the location of contact of RCC slab above in two coats, shall be straight run bitumen of specified grade.

5.14.2 Graded Gravel Free Draining Backfill

On each side of the uncoursed rubble walls supporting the slab culvert a free draining backfill of thickness 200 mm shall be provided. The material for this backfill shall be granular consisting of sound, tough, durable particles of crushed or uncrushed gravel, crushed stone or brickbats which will not become powdery under loads and in contact with water. The material shall be free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be graded and shall meet the grading requirements given in Table 5.10 hereunder.

Table 5.10

Sieve Designation	**Percent Passing by Weight**
10 mm	100
4.75 mm	30-65
425 microns	5-30
150 microns	0-10

5.14.3 Weep Holes

Weep holes as shown on the drawings or as directed by the Engineer shall be provided in the masonry to drain water from the backfilling. Weep holes shall be of asbestos cement pipes conforming to IS 6908 in rubble walls with necessary M10 concrete cushioning, 75 mm thick. They shall extend through the full width of the masonry at a spacing of 1.5 m c/c and with slope of about 1 vertical to 20 horizontal (or as shown on the drawings) towards the draining face.

5.15 Pipe Drains

Wherever required, pipe drains shall be provided for cross drainage purposes. The sequence of construction shall be as follows:

(a) laying of sand/shingle bedding on the original ground,
(b) laying of PCC of M10 grade,
(c) laying of concrete pipes of NP3 class as per IS 458,
(d) Constructing embankment above in compacted murum, laying of the sub-base and Wet mix Macadam as specified herein above.

The details of above works as directed by Engineer shall be followed.

5.15.1 Materials for Pipe Drains

All materials used in the construction of pipe drains shall conform to the requirements of the Specifications. RCC pipes of NP3 class shall conform to IS 458.

Each consignment of cement concrete pipes shall be inspected, tested if necessary, and approved by Engineer at the place of manufacture or at site before their incorporation in the Works.

5.15.2 Excavation for pipes

The foundation bed for pipe drain shall be executed true to the lines and grades shown on the drawings or as directed by the Engineer. The pipes shall be placed in shallow excavation of the natural ground in open trenches cut in the existing embankment, taken down to levels as shown in the drawings. Where trenching is involved, its width on either side of pipe shall not be less than 200 mm nor more than one third the diameter of pipe. The sides of the trench shall be as nearly vertical as possible.

When during excavation, the material encountered is soft, spongy or other unstable soil, unless other special construction methods are called for as indicated on drawings, such unsuitable material shall be removed upto a depth of 600 mm or as directed by the Engineer. Before placing any backfill material, exposed surface of the soft soil shall be lightly compacted with one pass of 0.5 T roller. On the lightly

compacted surface, coarse sand and shingle shall be spread in two successive layers of 300 mm and each layer shall be compacted by rolling with a min.0.5 T roller and with a minimum of 10 passes each, both in longitudinal and transverse directions.

When bed rock or boulder strata are encountered, excavation shall be taken down at least 300 mm below bottom level of pipe as directed by Engineer and space filled with approved sand and shingle and thoroughly compacted to provide adequate support for the pipes.

Trenches shall be kept free from water until the pipes are installed and the joints have been hardened. For this purpose, Contractor shall suggest necessary method for diverting the water.

5.15.3 Bedding for pipe

The bedding surface shall provide a firm foundation of uniform density throughout the length of the pipe drain and shall conform to the specified level and grade.

The pipe shall be bedded in a cradle of concrete having a mix not leaner than M-10. The pipes shall be laid on the concrete bedding before the concrete has set.

5.15.4 Laying of pipes

No pipe shall be placed in position until the foundations have been approved by Engineer. When pipes are to be laid adjacent to each other, they shall be separated by a distance atleast equal to or greater than half the diameter of pipe subject to a minimum of 450 mm.

The laying of pipes on the prepared concrete foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid they form a drain with a smooth uniform invert.

Any pipe found defective or damaged during laying shall be removed at the cost of the Contractor.

5.15.5 Jointing

All the joints shall be made with care so that their interior face is smooth and consistent with the interior surface of the pipes. The ends of the pipes should be so shaped as to form a self-centering joint with jointing space 13 mm wide. The jointing space shall be filled with cement mortar (1 cement to 2 sand)

mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. After finishing, the joints shall be kept covered and damp for at least four days.

5.15.6 Back filling

Trenches shall be backfilled with selected murum as per specifications given in this part. Backfilling upto 0.3 metre above the top of pipe shall be carefully done and murum shall be thoroughly consolidated under the haunches of the pipe.

5.16 Measurement

5.16.1 Slab Culvert

(a) Measurement of in-situ concrete work shall be as specified in Section 4 of this specification.

(b) Measurement of masonry shall be as specified in Section 8 of this specification.

(c) Bitumen at locations of contact with concrete surface shall be measured in square metres over area covered in plan and the rates shall include cleaning the surfaces, applying in two coats, etc., as specified.

(d) Graded gravel free draining backfill shall be measured in cubic metres and the rate shall include supplying, backfilling, etc., as specified.

(e) Measurement for weep holes shall be running metres and the rates shall include providing and fixing in rubble masonry walls with necessary concrete cushioning to lines and levels as specified.

5.16.2 Pipe Drains

Ancillary works such as excavation, backfilling, laying P.C.C below pipe, etc., shall be paid for separately, as provided under respective clauses.

End of Section-5

SECTION 6

STRUCTURAL STEEL WORK

SECTION 6

STRUCTURAL STEEL WORK

6 Applicable Codes and Specifications

The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless otherwise specified herein. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

1.	IS : 808	Dimensions for Hot Rolled Steel sections
2.	IS : 814	Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Maganese Steel
3.	IS : 800	Code of Practice for General Construction in Steel
4.	IS : 801	Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
5.	IS : 806	Code of Practice for Use of Steel Tubes in General Building Construction
6.	IS : 7205	Safety Code for Erection of Structural Steel Work
7.	IS : 7215	Tolerances for Fabrication of Steel Structures
8.	IS : 4000	High Strength Bolts in Steel Structure – Code of Practice
9.	AISC	Specifications for Design, Fabrication and Erection of Buildings
10.	IS : 1161	Steel Tubes for structural purposes
11.	IS:102	Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.
12.	IS:110	Ready Mixed paint, brushing, grey filler for enamels for use over primers.

13.	IS:117	Ready Mixed paint, Brushing, Finishing, Exterior Semigloss for general purposes, to Indian Standard colours.
14.	IS:158	Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
15.	IS:159	Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required.
16.	IS:341	Black Japan, Types A, B and C
17.	IS:2339	Aluminium paint for general purposes, in Dual container
18.	IS:2932	Specification for enamel, synthetic, exterior, type 1, (a) undercoating, (b) finishing
19.	IS:2933	Specification for enamel, exterior, type 2, (a) undercoating, (b) finishing
20.	IS:5905	Sprayed aluminium and zinc coatings on Iron and Steel.
21.	IS:6005	Code of practice for phosphating of Iron and Steel.
22.	IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
23.	IS:13183	Aluminium paint, Heat resistant.
24.	SIS-05-5900	(Swedish Standard)
25.	IS : 1239	Mild steel tubes, tubulars and other Wrought steel fittings Part 1 – Mild steel tubes Part 2 – Mild steel tubulars and other wrought steel pipe fittings
26.	IS : 1363	Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range M5 to M64)

	(Parts 1 to 3)	
27.	IS : 1367	Technical Supply Conditions for Threaded Fasteners
	(All parts)	
28.	IS : 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products
29.	IS : 1977	Structural Steel (Ordinary Quality)
30.	IS : 2062	Steel for General Structural Purposes
31.	IS : 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
32.	IS : 3502	Steel Chequered Plate
33.	IS : 3757	High Strength Structural Bolts
34.	IS : 5369	General Requirements for Plain Washers and Lock Washers
35.	IS : 5372	Taper Washers for Channels
36.	IS : 5374	Taper Washer for 1 Beams
37.	IS : 6610	Heavy Washers for Steel Structures
38.	IS : 8500	Structural Steel-microalloyed (medium and high strength qualities)
39.	IS : 803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
40.	IS : 816	Code of Practice for use of Metal Arc Welding for General construction in Mild Steel
41.	IS : 822	Code of Procedure for Inspection of Welds
42.	IS : 1182	Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
43.	IS : 1200	Method of Measurement in Building Civil Works
44.	IS : 1477	Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
45.	IS : 2595	Code of Practice for Radiographic Testing

46.	IS : 3658	Code of Practice for Liquid Penetrant Flaw Detection
47.	IS : 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
48.	IS : 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel
49.	IS : 1367	Technical, Supply, Conditions for steel (Part 13) threaded fasteners
50.	IS : 1573	Electroplated Coating of Zinc on Iron and Steel
51.	IS : 2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
52.	IS : 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles
53.	IS : 4736	Hot Dip Zinc coating on Mild steel tubes
54.	IS : 4759	Hot Dip Zinc coating on Structural Steel and other Allied products
55.	IS : 5905	Sprayed Aluminium and Zinc Coatings on Iron and Steel
56.	IS : 6158	Recommended Practice for Safeguarding against Embrittlement of Hot Dip Galvanised Iron and Steel
57.	IS : 6159	Recommended Practice for Design and preparation of Material Prior to Galvanising
58.	IS : 6745	Methods for Determination of Weight of Zinc Coating on Zinc coated Iron and Steel Articles

6.2 Steel Materials

Steel materials shall comply with the codes referred to in Sub-Clause 6.1.
All materials used shall be new, unused and free from defects.

Steel conforming to IS:1977 shall be used only for the following:

Fe310-0(St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.

Fe410-0(St 42-0)	For structures not subjected to dynamic loading other than wind loads such as : Platform roofs, foot over bridges, building, factory sheds etc.
Fe10-0(St 42-0)	Grade steel shall not be used a) If welding is to be employed for fabrication b) If site is in severe earthquake zone c) If plastic theory of design is used

6.3 Drawings prepared by the Employer

Design drawings will be furnished to the Contractor and all drawings so furnished shall form a part of this specification in case of Item Rate Contracts. These design drawings prepared by the Engineer will show all the levels, forces on members where shall necessary, size and orientation of each member, location/size of openings to enable the Contractor to prepare drawings for fabrication and erection. It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details.

The Engineer reserves the right to make changes. Revisions to drawings, even after release for preparation of shop drawings, are very likely to be made to reflect additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the Contractor shall be considered a part of this specification and contract. The Employer shall not entertain any extra claims on this account.

Where the fabrication drawings are to be furnished by the Engineer, he will issue to the Contractor the required copies of such drawings in the sequence required for the fabrication of the components in the order they will be required to be erected at site. Such drawings will be issued in such numbers as required for the Contractor to adhere to the project schedule.

Should the Contractor during the execution of his work, find discrepancies in the information furnished by the Engineer, he shall refer such discrepancies to the Engineer before proceeding with the work.

6.4 Drawings prepared by the Contractor

The Contractor shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

The Contractor shall not commence detailing unless Engineer's design drawings are officially released for preparation of shop drawings. The Contractor shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the Contractor to reflect all revisions in design drawings as and when such revisions are made by the Engineer.

All fabrication drawings shall be submitted to the Engineer for approval.

No fabrication drawings will be accepted for Engineer's approval unless checked and approved by the Contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The Contractor shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the Contractor only after Engineer's approval of fabrication drawings. Approval by the Engineer of any of the drawings shall not relieve the Contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The Engineer's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the Contractor and all subsequent revisions etc. shall be at the cost of the Contractor for which no separate payment will be made.

6.5 Fabrication

6.5.1 General

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and

accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise approved by the Employer's Representative, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

6.5.2 Connections

Shop/field connections shall be as per approved fabrication drawings.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers are used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws etc., shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

All members likely to collect rain water shall have drain holes provided.

6.5.3 Straightening

All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the Employer's Representative in writing.

6.5.4 Rolling and Forming

Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

6.5.5 High Strength Friction Grip Bolting

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

6.5.6 Welding

Welding procedure shall be submitted to the Employer's Representative for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS : 7310 (Part 1) and IS : 7318 (Part 1).

While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the Employer's Representative shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

No welding shall be done on base metal at a temperature below –5 Deg.C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

All welds shall be inspected for flaws by any of the methods described under Sub-clause 6.8.3. The choice of the method adopted shall be agreed with the Employer's Representative.

The correction of defective welds shall be carried out in a manner approved by the Employer's Representative without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means approved by the Employer's Representative shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. The cost of all such tests and operations incidental to correction shall be borne by the Contractor.

6.6 Tolerances

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS : 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS : 7215.

Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

6.7 End Milling

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

6.8 Inspection

6.8.1 General

The Contractor shall give due notice to the Employer's Representative in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Employer's Representative's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Employer's Representative if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or despatched to site without inspection and approval by the Employer's Representative unless such inspection is waived in writing by the Employer's Representative.

The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Employer's Representative.

Inspection and tests on structural steel members shall be as set forth below.

6.8.2 Material Testing

If mill test reports are not available for any steel materials the same shall be tested by the Contractor to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

6.8.3 Tests on Welds

6.8.3.1 Magnetic Particle Test

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the Employer's Representative.

6.8.3.2 Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

6.8.3.3 Radiographic Inspection

All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

6.8.4 Dimensions, Workmanship & Cleanliness

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabrication drawings.

6.8.5 Test Failure

In the event of failure of any member to satisfy inspection or test requirement, the Contractor shall notify the Employer's Representative. The Contractor must obtain permission from the Employer's Representative before any repair `is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Employer's Representative.

The Employer's Representative has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Employer, only in case of successful testing.

The Contractor shall maintain records of all inspection and testing which shall be made available to the Employer's Representative.

6.9 Shop Matching

For structures like bunkers, tanks, etc. Shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the Employer's Representative. All these shop assemblies shall be carried out by the Contractor.

6.10 Marking of Members

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

6.11 Errors

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Employer's Representative as defective workmanship. Where the Employer's Representative rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to these Employer's Requirements by the Contractor, at no cost to the Employer.

6.12 Site Operations

The Contractor shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc., as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel on site.

The Contractor shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. The Contractor shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of the Employer's Representative and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain the Contractor's electrical equipment and connections.

The Contractor shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by contractor shall be rectified entirely at his cost, to the satisfaction of the Employer's Representative. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, the Contractor must ensure suitable safety precautions in consultation with Employer's Representative.

If a portion of the work of the project area cannot be made available to the Contractor for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations

so as to continue work without interruption. The Contractor shall work in co-ordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

6.13 Acceptance of Steel, its Handling & Storage

The Contractor shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of the Employer's Representative.

No dragging of steel shall be permitted. All steel shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by the Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with these Employer's Requirements for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from damage.

6.14 Anchor Bolts & Foundations

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to the Employer's Representative.

Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by the Contractor at no extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by the Contractor.

6.15 Assembly & Connections

Field connections may be effected by riveting, bolting, welding or by use of high strength friction grip bolts as shown on the design and erection drawings.

All field connection work shall be carried as per the drawings prepared by the Contractor. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by the Contractor.

All assembling shall be carried on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the normal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of the Employer's Representative.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the Employer's Representative.

6.16 Erection

All structural steel shall be erected as shown on the drawings prepared by the Contractor. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc., unless so permitted by the Employer's Representative in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at points such that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as approved by the Employer's Representative. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

(a) Welding of stiffening angles/vertical stiffening ribs
(b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through
(c) Splicing as shown in relevant drawings
(d) Smoothening of edges
(e) Fixing of chequered plates by tack welding or by countersunk bolts
(f) Providing lifting hooks for ease of lifting.

As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Employer's Representative. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of the Employer's Representative.

Test certificates shall be furnished by the Contractor.

6.17 Inspection

The Employer's Representative shall have free access to all parts of the job during erection and all erection shall be subjected to his approval. In case of faulty erection, all dismantling and re-erection required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the Employer's Representative.

6.18 Tolerances

6.18.1 General

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb.

6.18.2 Columns

Deviation of column axes at foundation top level with respect to true axes:

(a)	In longitudinal direction	±5 mm
(b)	In lateral direction	±5 mm

Deviation in the level of bearing surface of columns at foundation top with respect to true level	±5mm

Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top:

(a)	For columns upto and including 15 metres in height	±1/1000 of column height in mm or ±15 mm whichever is less
(b)	For columns exceeding 15 metres in height	±1/1000 of column height in mm or ±20 mm whichever is less

Deviation in straightness in longitudinal and transverse planes of column at any point along the height	±1/1000 of column height in mm or ±10 mm whichever is less
Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance	±10mm
Deviation in any bearing or seating level with respect to true level	±5 mm
Deviation in differences in bearing level of a member on adjacent pair of columns	±10 mm

both across and along the building

6.18.3 Trusses and Beams

Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	±1/250 of height of truss in mm or ±15 mm whichever is less
Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	±1/1500 of span of truss in mm or ±15 mm whichever is less
Lateral shift in location of truss from its true vertical position	±10 mm
Lateral shift in location of purlin true position	±5 mm
Deviation in difference of bearing levels of trusses or beams from the true difference	i) ±20 mm for trusses ii) For beams : Depth < 1800mm : ±6mm Depth > 1800mm : ±10mm
Deviation in sag in chords and diagonals of truss between node points	1/1500 of length in mm or 10mm whichever is smaller
Deviation in sweep of trusses, beams etc. in the horizontal plane	1/1000 of span in mm subject to a maximum of 10 mm

6.18.4 Crane Girders & Rails

Shift in the centre line of crane rail with	±5 mm

respect to centre line of web of crane girder	
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	±5 mm
Difference in alignment of crane rail in plan measured between any two points 2 metres apart along rail	±1 mm
Deviation in crane track with respect to Time gauge	
(a) For track gauges upto and Including 15 metres	±5 mm
(b) For track gauges more than 15 metres	± [5 + 0.25 (S-15)] where S in metres is true gauge
Deviation in the crane rail level at any point from true level	±1/1200 of the gauge distance or ±10mm whichever is less
Difference in the crane rail actual levels between any two points 2 metres apart along the rail length	±2 mm
Difference in levels between crane track Rails at	
(a) Supports of crane girders	±15 mm
(b) Mid span of crane girders	± 20 mm
Relative shift of crane rail surfaces at a joint in plane and elevation	2 mm subject to grinding of surfaces for smooth transition

Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm	1/1000 of track gauge S in mm subject to maximum of 20 mm

6.19 Clean up of Work Site

During erection, the Contractor shall at all times keep the working and storage areas used by him free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to the Employer's Representative.

6.20 Painting

6.20.1 General

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

6.20.2 Surface Treatment

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The workmanship shall generally conform to the requirements of IS 1477-Part I.

Oil and grease removal shall be carried out either by solvent cleaning or by using alkali type degreasing agents. To remove grease material the surface shall be cleaned with solvents containing emulsifier. After cleaning, the surface shall be washed with water. When the surface has cement pelter or salts, the cleaning shall be done with strong alkalies. After cleaning, water rinsing and subsequent passivation by dilute chromic acid rinsing shall be carried out to ensure that no traces of alkali is left on the surface. The procedure for cleaning by above mentioned methods shall be as per manufacturer's instructions.

Derusting and descaling of steel shall be carried out either manually, mechanically or chemically.

6.20.2.1 Manual or Hand Tool Cleaning

Loose mill scale, loose rust and loose paint shall be removed by wire brushing, scrapping, chipping, rubbing with abrasive paper or steel wool. This method shall not be employed when the surface has firmly adhering mill scale. After hand tool cleaning, the surface shall be rubbed with sand paper so as to ensure that no loose material exists and the surfaces shall be dusted off.

6.20.2.2 Mechanical Cleaning

Power Tool Cleaning:

This shall be carried out by employing power operated wire brushes. Power tool cleaning shall be resorted to only if sand/shot blasting is not possible/permissible and high quality of surface preparation is required. The surface prior to treatment shall have been cleaned of dust and grease and heavier layers of rust removed by chipping.

The powertool cleaning shall remove loose mill scale and rust by adopting very thorough scrapping, grinding and machine brushing. After the surfaces are cleaned by compressed air, it shall have a pronounced metallic sheen.

Flame Cleaning:

Hard mill scale and rust shall be removed through Oxy- acetylene flame. The work shall be carried out by trained workmen to ensure that only mill scale is removed without heating the parent steel. The work shall be carried out carefully on welded surfaces so that the strength of weld is not affected due to heating.

6.20.2.3 Sand Blasting and Shot Blasting

Sand/shot blasting shall only be carried out after removal of grease, oil and other contaminants. The work shall be carried out by impinging under pressure of air, a jet of sharp sand or granulated steel (steel grits) on to the metal surface. The process shall ensure complete removal of rust and firmly adhering mill scale. Special care shall be taken on weld areas to remove flux and spatter. Blasting shall ensure an even colour of the surface and the surface shall have silver grey colour. Precautions shall be taken when sand or shot blasting of light gauge steel surfaces to ensure that buckling does not occur due to continuous impingement of sand or steel shots under high velocity.

Sand/shot blasting shall be adopted for structures which are exposed to corrosive conditions for which superior paint protection is to be adopted. The finished surfaces shall conform to the requirements of Sa 2.5 or Sa 3 as per Swedish Standard SIS-05-5900 as required.

As sand blasting causes dust nuisance, necessary clearance shall be obtained by the Contractor from the Competent authorities prior to commencing sand blasting.

6.20.2.4 Chemical Cleaning (Pickling)

The cleaning shall be done by pickling in sulphuric, hydrochloric or phosphoric acids. Pickling shall be carried out in accordance with detailed procedure as given in IS 6005.

Washing after pickling shall remove all traces of the acids. All work pieces shall be thoroughly inspected and in particular the inaccessible corners.

All surfaces shall be cleaned thoroughly as per manufacturer's specification before application of primer.

6.20.3 Materials

6.20.3.1 Primer Paint

Anti-corrosive primers shall be either lead based or lead free types. Red lead primer shall conform to IS 102 and red oxide zinc chrome primer shall conform to IS 2074.

6.20.3.2 Finish Paint

Epoxy primer and epoxy paint shall be of the type as specified from an approved manufacturer.

Chlorinated rubber based paint shall be of the manufacture as specified or any equivalent approved manufacture.

All the materials shall be of the best quality from an approved manufacturer. The Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade prior to procurement for usage in the works.

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.

The colour and shade shall be conforming to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade number from the alternatives available, the Contractor shall adopt trial painting in small patches in consultation with and as approved by the Employer's Representative.

All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically approved so by the Employer's Representative.

Paints shall be stirred thoroughly to keep the pigment in suspension.

The Contractor shall arrange for testing of paints as per relevant Indian Standards in an approved laboratory whenever the Employer's Representative requires the tests to be carried out for each batch of paints. Test results shall be submitted to the Employer's Representative for approval.

6.20.4 Workmanship

The type and the number of coats of the primer paint and finish paint shall be as specified.

Painting shall be carried out only on thoroughly dry surfaces.

No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 5deg.C or lower.

Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

Workmanship shall generally conform to requirements specified in IS:1477-Part II.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of primer paint shall be applied by brushing and working it well to ensure a continuous film. After the first coat becomes hard dry a second coat of primer shall be applied by brushing.

Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surfaces of the first coat during transport from shop to site and during erection shall be provided with a touch-up coat of the primer.

The dry film thickness of each coat of primer shall be not less than 25 microns.

Application of finishing paints shall be carried out within the shortest possible time interval after primer since the primer coats are too thin to give adequate corrosion protection of the steel surface over a long duration.

Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Fillers prepared by whiting and linseed oil by craftsmen at site shall not be used. Application of filler shall be done with good `putty knife' and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats shall be applied over the undercoats also.

Painting shall be carried out either by brushing or by spraying. The Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of paint of optimum thickness shall be applied by brushing/spraying with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing or by spraying and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing or by spraying.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and shall be approved by the Employer’s Representative, prior to applying the next coat.

Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.

The thickness of film shall be measured by an Elcometer to be supplied by the Contractor. The Contractor shall calibrate the Elcometer frequently for different settings. Necessary calibrating accessories should be kept ready for calibration / testing of the Elcometer at any time.

Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection, including top surfaces of floor beams, supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

Portion of steel members embedded/to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall received the painting as specified.

Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting. It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause.7 of IS 1477 – Part II.

The Contractor shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls, etc.

6.21 Method of Measurement

For the purpose of payment, the weight of the actual, completed structures shall be calculated from the approved drawings for different items of work. Contractor shall submit to Employer relevant material list containing weight of each item.

No allowance will be permitted for weights of rivets, bolts, washers, screws etc. in calculating the weight of the completed structure. No allowances will be permitted for galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean One Metric Tonne i.e. 1000 kg.

The weight of a member made out of standard rolled sections such as beams, channels, angles, etc. shall be based on the weight of the member given in IS 808, without deducting for hole, notches, bevel cuts, etc. Where a component consists of a cut joist or channel, the full weight of the rolled section shall be considered only if more than half the depth of the section is used. Otherwise only half the section unit weight shall be

taken. Deductions shall be made in the weight of gussets/plates including chequered plates for skew cuts, notches and openings of 900 sq.cm. or larger.

For gussets/plates used in trusses, bracings, columns, beams etc. the area shall be that of the minimum circumscribing rectangle, except as stated above.

The weight of any built-up member shall be separated into the weight of each component.

Erection bolts installed by erector may be left in position on completion of erection; however, no additional payment shall be made either for supply or use of such bolts. If erection bolts are removed after erection is complete, holes shall be plug welded and ground smooth. No extra payment shall be made for such plug welding.

Painting work shall not be measured separately, if primer painting and/or primer and finish painting is deemed to be included in the scope of the item of work of fabrication and erection of structural steel since the rate per tonne of steel is deemed to include for painting as specified.

In cases where primer and/or finish painting work as specified is carried out on erected structural steel executed by a different agency, the method of measurement for painting shall be on the basis of tonnage of steel erected. For this purpose, the tonnage of erected steel as certified for payment to the different agency shall be considered as the basis and no measurement will be carried out separately.

6.22 Galvanising of Structural Steel

6.22.1 Galvanising Plant

Prior approval shall be obtained from Employer / Engineer if galvanising is proposed to be carried out outside Contractor's plant.

6.22.2 Workmanship

After all shop work is complete, all structural materials shall be punched with the erection mark and be hot-dip galvanised. Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process or with the quality and durability of the zinc coating. Pickling shall be very carefully done and shall be proper.

The weight of the zinc coating shall be at least 0.610 kg/sq.m unless specified otherwise. Stub members and members for grillage type footing shall have heavier zinc coating not less than 0.80 kg/sq.m.

The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel, globules, spiky de S:2633 unless specified otherwise.

All galvanised members shall be treated with Sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.

Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However, in case of members over 7.5 M long, the Contractor shall take prior approval of Engineer for double dipping. When the steel section is removed from the galvanising kettle, excess spelter shall be removed by 'bumping'.

Wherever galvanised bolts, nuts locknuts, washers, accessories etc. are specified, they shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Rechasing of bolt threads after galvanising shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications, or lack of quality control in any manner in the galvanising plant, shall render the entire production in the relevant shift liable to rejection.

Contractor shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damages Contractor shall at his own cost adopt scrapping and regalvanising the member to satisfy the specific requirements.

End of Section-6

SECTION 7

WATER SUPPLY AND SANITARY WORKS

SECTION 7

WATER SUPPLY AND SANITARY WORKS

7.1 Applicable Codes

The following standards and codes are made a part of this Employer's Requirement. All standards, codes of practice referred to herein shall be the latest editions including all official amendments and revisions.

IS : 210	:	Specification for grey iron castings
IS : 269	:	Specification for Ordinary Portland cement
IS : 383	:	Specification for coarse and fine aggregates from natural sources for concrete
IS : 432	:	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS : 456	:	Code of Practice for plain and reinforced concrete
IS : 458	:	Concrete Pipes (with and without reinforcement).
IS : 516	:	Methods of tests for strength of concrete
IS : 554	:	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 651	:	Salt glazed stoneware pipes and fittings.
IS : 774	:	Flushing Cisterns for water closets and urinals (valveless siphonic type)
IS : 775	:	Cast iron brackets and supports for wash basins and sinks.
IS : 781	:	Sand-cast brass screw-down bib taps and stop taps for water services.

IS : 783	:	Code of practice for laying of concrete pipes.
IS : 1068	:	Electroplated coatings of nickel and chromium of iron and steel.
IS : 1077	:	Specification for common burnt clay building bricks
IS : 1786	:	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS : 1239	:	Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II)
IS : 1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS : 1626	:	Asbestos cement building pipes, gutters and fittings (spigot and socket types).
IS : 1703	:	Copper Alloy float valves (horizontal plunger type) for water supply purposes.
IS : 1726	:	Cast iron manhole covers and frames.
IS : 1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 1742	:	Code of practice for buildings drainage
IS : 2116	:	Specification for sand for masonry mortars
IS : 2212	:	Code of practice for brickwork
IS : 2250	:	Code of practice for preparation and use of masonry mortars
IS : 2326	:	Automatic flushing cisterns for urinals
IS : 2470	:	Code of practice for design and construction of septic tanks (Parts I & II)
IS : 2556	:	Vitreous sanitary appliances (Part I to Part XV)
IS : 2963	:	Specification for copper alloy waste fittings for wash basins and sinks

IS : 3006	:	Specification for chemically resistant glazed stoneware pipes and fittings
IS : 3311	:	Waste plug and its accessories for sinks and wash basins
IS : 5455	:	Specification for cast iron steps for manholes
IS : 4127	:	Code of Practice for laying of glazed stoneware pipes
IS : 3495	:	Methods of tests of burnt clay building bricks
IS : 4111	:	Code of practice for ancillary structures in sewerage system manholes
IS : 5382	:	Specification for rubber sealing rings for gas mains, water mains and sewers
IS : 5329	:	Code of practice for sanitary pipe work above ground for buildings
IS : 5434	:	Non-ferrous alloy bottle traps for marine use

IS : 4985 : Specifications for Unplasticized PVC pipes for potable water supplies

IS : 7634 : Code of Practice for Plastic pipes selection, Handling, storage and installation for Potable water supplies

IS : 13592 : Specifications for Unplasticized Polyvinyl chloride pipes for soil and waste discharge system for inside and outside buildings injcluding ventilation and rain water system

7.2 Sanitary Installation

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Employer's Representative.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

All sanitary and plumbing work shall be carried out by licensed plumbers.

All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of size, and design as approved by the Employer's Representative.

All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, `P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used.

Joints between iron and earthenware pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

7.3 Indian Type Water Closet

This shall be the long pan pattern with separate footrests made of white glazed earthenware; white glazed vitreous china or of white glazed fire clay. The general requirements shall conform to IS:2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush type. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise approved by the Employer's Representative. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap `P' or `S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1 part lime mortar to 2 parts brick bats with lime mortar to 2 parts of sand) or cement-sand admixture as specified in the drawings.

7.4 European Type Water Closet

Water closets shall be either of white glazed earthenware, white grazed vitreous china or white glazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one piece construction with approved plastic/bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an antisiphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

7.5 Urinals

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

7.6 Wash Basins

Wash basins shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative and conforming to IS.2556

Type	Size
Flat Back	630 x 450 mm
Flat Back	550 x 400 mm

Wash basins shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each shall have a rim sloping inside towards the bowl on all sides except skirting at the back. Basins shall be provided with single or double tap holes as approved. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or bevelled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with a non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the under side of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 sq.cm. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The Employer's Requirements for waste plug, chain and stay shall be the same as given for sinks.

All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

7.7 Sinks

The sinks shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative conforming to IS.2556 (Part V) and shall be of the following sizes:

450 x 300 x 150 mm

600 x 450 x 200 mm

They shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS.2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS.1068.

7.8 Flushing Cisterns

The flushing cisterns shall be automatic or manually operated, high level or low level, as approved by the Employer's Representative. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying iron, glazed requirement of IS.774. Automatic flushing cistern for urinals shall conform to IS.2326.

7.9 Un plasticised PVC pipes and fittings:

Unplastiscised polyvinyl Chloride Pipe for Soil and Waste Discharge System for Inside and Outside Buildings Including Ventilation and Rain Water System IS 13592 and IS 14735 Specification

UPVC Injection Moulded Fittings for Soil and Waste Discharge.

Unplasticised polyvinyl chloride pipes, fittings and specials shall be to BS 3505 for portable water and BS 4346: Part 1for fitting.

The pipe shall be of the spiogot and socket type with approved gasket type flexible joint. The rubber gasket shall be to BS 2494, Class C.

IS 7634 Plastic pipe selection, handling storage and installation for portable water supply.

Where PVC pipes, fittings and specifications are to be connected to cast iron, stainless steel or steel pipes, all metallic pipes, Viking Johnson type flange adopted or stepped coupling shall be used.

7.10 Stoneware pipes and fittings

All pipes with spigot and socket ends shall conform to IS.651/3006 and shall be of grade `A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

The following information shall be clearly marked on each pipe and fitting :

(a) Internal diameter;

(b) Grade;

(c) Date of manufacture;

(d) Name of manufacturer or his registered trade-mark or both.

All pipes and fittings shall have ISI mark.

Jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant BIS. After jointing, extraneous material if any, shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS : 5382.

7.10.1 Spigot and Socket Joint (Cement Joint)

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of a caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one- fourth of the depth or socket.

Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall than be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished of neatly outside the socket at an angle of 45 degrees.

The cement mortar joints shall be cured at least for seven days before testing.

The approximate quantity of cement required for each joint for certain common sizes of pipes are given below for guidance :

Nominal diameter of pipe (mm)	**Cement (kg)**
150	1.5
200	2.0
250	2.5
300	3.25
350	4.5

400	5.5
450	6.5

7.10.2 Spigot and Socket Joint (Bituminous Joint)

The material for jointing shall consist of composition of asphalt and sand in the ratio of 1:7. Asphalt and sand shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

7.10.3 Spigot and Socket Joint (Rubber Ring Joint)

The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS : 5382 shall be used, and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

7.10.4 Cleaning of Pipes

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Employer's Representative, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Employer's Representative to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction the Employer's Representative considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be tested immediately. Should such test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Employer's Representative.

It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Employer's Representative is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following Employer's Requirements and as approved by the Employer's Representative. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Employer's Representative. Water used for test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Employer's Representative and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water, if necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head; or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The tolerance of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified. The Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Employer's Representative.

Water for testing of pipeline shall be arranged by the Contractor.

7.11 Stop Cock and Bib Cock

A bibcock (bibtap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. in finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, roughness and shall not be stained or discoloured.

These fittings shall be of brass heavy class, chromium plated (C.P) and of approved manufacture and pattern with screwed of flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be approved by the Employer's Representative and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be made

leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test approved by the Employer's Representative and the defective fittings and joints shall be replaced or redone.

7.12 Soak Pit

Soak pit shall be constructed at the location specified by the Employer's Representative. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit upto 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level upto ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

7.13 Manholes

7.13.1 Location

Manholes shall be constructed at places approved by the Employer's Representative.

7.13.2 Excavation

Excavation, shoring, dewatering etc. for the pits of manholes, laying of pipes and fittings/specials shall be done in accordance with Employer's Requirements described elsewhere in the document.

7.13.3 Bed Concrete

The bed concrete for manholes shall be done in accordance with Employer's Requirements described elsewhere in the document.

7.13.4 Bricks

Bricks used for construction of manholes shall conform to the relevant Indian Standards. They shall be Wire cut bricks/ Table moulded type, sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and

square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ungrounded particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 kg/sq.cm. unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS : 1077.

The size of the brick shall be 23.0 x 11.5 x 7.5 cm. unless otherwise specified; but tolerance upto ± 3 mm in each direction shall be permitted. Only full size brick shall be used for masonry work. Brick bats shall be used only with the permission of Employer's Representative to make up required wall length or for bonding. Sample bricks shall be submitted to the Employer's Representative for approval and bricks supplied shall conform to approved samples. If required by the Employer's Representative, brick sample shall be tested as per IS : 3495 by Contractor. Bricks rejected by the Employer's Representative shall be removed from the Site within 24 hours.

7.13.5 Cement Mortar

Mortar for brick masonry shall be prepared as per IS : 2250. Manholes shall be constructed in brick masonry with cement mortar (1:2) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg. of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by the Employer's Representative. If required by the Employer's Representative sand shall be thoroughly washed till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

The Contractor shall arrange for tests on mortar samples if so required by Employer's Representative. Retempering of mortar shall not be permitted.

7.13.6 Brick Masonry

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb and square unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified.

All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS : 2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

7.13.7 Cement Plaster

All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

Plastering work shall be carried out in two layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Employer's Representative.

7.13.8 Cement Concrete Channel

The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

7.13.9 Pipe Entering or Leaving Manhole

Whenever a pipe enters or leaves a manhole, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

7.13.10 PVC encapsulated Rungs

Rungs shall meet the dimensions as specified in IS : 5455. Material shall be in Fe415 or Fe500 plastic encapsulated. The steps shall be clean, well cast and they shall be free from air and sand holes, cold shuts and warpings. The portion of the step which projects from the wall of the manhole shall have adequate non-slip grip.

Where the depth of invert of manhole exceeds 800 mm, the steps of approved pattern shall be fixed in the brick work or RCC at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type steps shall be provided at 300 mm vertically in channel of manhole.

7.13.11 Frame and Covers

Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings prepared by the Contractor. Following information shall be clearly marked on each cover.

Year of manufacture,

Identification mark of the purchaser,

SEWERS/SWD,

Arrow showing direction of flow

7.13.11.1 Cast Iron Frame and Cover

The cast iron frame and cover shall be of grey cast iron as per IS : 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause 7.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequer shall be not less than 4 mm. The locking device for the cover shall be provided as approved by the Employer's Representative. The CI covers for the load test shall

be selected at one for every lot of fifty or part thereof for each type and size manufactured and as approved by the Employer's Representative. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper manhole the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

7.13.11.2 Fibre Reinforced Concrete Frame and Cover

Fibre reinforced concrete frame and cover shall be capable of withstanding load of 35 tonnes. The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement. The fibre reinforced frame shall have clear opening of 560 mm diameter and weighing 102 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fibres shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 18 gauge shall be provided to avoid damage to the edges. Similarly for frame, MS angle/flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fibre reinforced frame and cover shall be manufactured as approved.

7.13.11.3 Reinforced Cement Concrete Frame and Cover

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shape as shown on the drawing prepared by the Contractor. The frame and cover shall be cast in cement concrete of M25 grade. Minimum cover to

the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

7.13.12 Drop Manhole

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

In the case of sewers over 450 mm in diameter the drop in level may be accomplished by one of the following approved methods:

(a) A cascade;

(b) A ramp;

(c) By drops in previous manholes.

7.13.13 RCC Manhole

M30 grade of concrete used for construction of RCC manhole shall have minimum cement content of 400 kg/cum of concrete. Minimum cover to the reinforcement shall be 50 mm.

7.13.14 Vent Shafts

7.13.14.1 General

Vent shafts shall be erected at such places as approved by the Employer's Representative.

7.13.14.2 Mild Steel Vent Shaft

Mild steel vent shaft shall be of 150 mm diameter and 12.17 m height from ground level with C.I. ornamental cap. This shall be fixed firmly and encased in cement concrete of M15 grade as shown on relevant drawing with necessary mild steel bolts, plates etc. for foundation. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The vent shaft shall be connected to manhole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Employer's Representative.

7.13.14.3 RCC Vent Shaft

Reinforced cement concrete vent shaft shall be of M30 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to manhole as specified in (b) above through a brick masonry flue chamber.

7.13.15 Miscellaneous

If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of manholes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Employer's Representative.

The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness by the Contractor.

7.14 Measurement for Pipes

AC, Cast iron and S.W. drainage pipes shall be measured along the centrelines of pipes including all fittings such as junctions, plug bends etc., for which no separate payment shall be made.

GI pipes with fittings completely fixed in position shall be measured and paid for the finished centreline lengths, including all fittings such as tees, bends, couplings etc., for which no separate payment shall be made.

In measuring the lengths of sewer pipes laid, length between faces of manholes shall be considered. Inspection chambers shall only be measured omitting lengths of channels between inside faces of walls of manholes of chambers.

End of Section-7

SECTION 8

GENERAL CIVIL WORKS

SECTION 8

GENERAL CIVIL WORKS

8.1 Applicable Codes and Specifications

The following codes and standards are included in this section.

IS:110 - Ready mixed paint, brushing, grey filler, for enamels for use over primers

IS:269 - Specification for Ordinary Portland cement

IS:280 - Specification for mild steel wire for general engineering purposes

IS:287 - Recommendations for maximum permissible moisture content of timber used for different purposes

IS : 304 - High Tensile Brass Ingots and Castings.

IS:337 - Varnish, finishing interior

IS:348 - French polish

IS:383 - Specification for coarse and fine aggregates from natural sources for concrete

IS:412 - Expanded metal steel sheets for general purposes

IS:419 - Specification for putty for use on window frames

IS:428 - Distemper, oil emulsion, colour as required

IS:459 - Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets

IS:702 - Specification for industrial bitumen

IS:710 - Specification for marine plywood

IS:712 - Specification for building limes

IS:730 - Specification for hook bolts for corrugated sheet roofing

IS:733 - Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes

IS:777 - Specification for glazed earthenware tiles

IS:1003 - Specification for timber panelled and glazed shutters (Parts 1 & 2)

IS:1038 - Specification for steel doors, windows and ventilators

IS:1077 - Specification for common burnt clay building bricks

IS:1081 - Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators

IS:1124 - Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones

IS:1237 - Specification for cement concrete flooring tiles

IS:1322 - Bitumen felts for water proofing and damp proofing

IS:1346 - Code of practice for water proofing of roofs with bitumen felts

IS:1361 - Specification for steel windows for industrial buildings

IS:1397 - Specification for kraft paper

IS:1443 - Code of practice for laying and finishing of cement concrete flooring tiles

IS:1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)

IS:1542 - Specification for sand for plaster

IS:1580 - Specification for bituminous compounds for water-proofing and caulking purposes

IS:1597 - Code of practice for construction of stone masonry : Part 1 Rubble stone masonry

IS:1659 - Specification for block boards

IS:1661 - Code of practice for application of cement and cement-lime plaster finishes

IS:1834 - Specification for hot applied sealing compound for joint in concrete

IS:1838 - Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type) : Part 1 Bitumen impregnated fibre

IS:1948 - Specification for aluminium doors, windows and ventilators

IS:1949	-	Specification for aluminium windows for industrial buildings
IS:2074	-	Ready mixed paint, air drying, red oxide- zinc chrome, priming
IS:2098	-	Asbestos cement building boards
IS:2114	-	Code of practice for laying in-situ terrazzo floor finish
IS:2116	-	Specification for sand for masonry mortars
IS:2185	-	Specification for concrete masonry units (Parts 1,2 & 3)
IS:2202	-	Specification for wooden flush door shutters (Solid core type) : Parts 1 & 2
IS:2212	-	Code of practice for brickwork
IS:2250	-	Code of practice for preparation and use of masonry mortars
IS:2338	-	Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
IS:2339	-	Aluminium paint for general purposes, in dual container
IS:2395	-	Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
IS:2402	-	Code of practice for external rendered finishes
IS:2571	-	Code of practice for laying in-situ cement concrete flooring
IS:2645	-	Specification of integral cement waterproofing compounds
IS:2690	-	Specification for burnt clay flat terracing tiles : Part 1 Machine made
IS:2691	-	Specification for burnt clay facing bricks
IS:2750	-	Specification for steel scaffoldings
IS:2835	-	Flat transparent sheet glass
IS:2932	-	Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing
IS:3007	-	Code of practice for laying of asbestos cement sheets - corrugated and semi-corrugated sheets (Part 1 & 2)
IS:3036	-	Code of practice for laying lime concrete for a water-proofed roof finish

IS:3067	-	Code of practice of general design details and preparatory work for damp-proofing and water- proofing of buildings
IS:3068	-	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
IS:3384	-	Specification for bitumen primer for use in water-proofing and damp-proofing
IS:3461	-	Specification for PVC-asbestos floor tiles
IS:3462	-	Specification for unpacked flexible PVC flooring
IS:3495	-	Method of test for burnt clay building bricks: Part 1 to 4
IS:3536	-	Specification for ready mixed paint, brushing, wood primer, pink
IS:3564	-	Specification for door closers (hydraulically regulated)
IS: 3614 (Part – 1)		Specification for fire checks doors : Part –I Plate metal covered and rolling type
IS: 3614 (Part – 2)	-	Specification for metallic and non-metallic fire check doors : Part-2 Resistance test and performance criteria
IS:3696	-	Safety code of scaffolds and ladders (Parts 1 & 2)
IS:4020	-	Methods of test for wooden flush door : Type test
IS:4021	-	Specification for timber door, window and ventilator frames
IS:4351	-	Specification for steel door frames
IS:4443	-	Code of practice for use of resin type chemical resistant mortars
IS:4457	-	Specification for ceramic unglazed vitreous acid resisting tile
IS:4631	-	Code of practice for laying epoxy resin floor toppings
IS:4832	-	Specification for chemical resistant mortars (Part II)
IS:4860	-	Specification for acid resistant bricks

IS:4948	-	Specification for welded steel wire fabric for general use
IS:5318	-	Code of practice for laying of flexible PVC sheet and tile flooring
IS:5410	-	Cement paint, colour as required
IS:5411	-	Specification for plastic emulsion paint (Parts 1 & 2)
IS:5437	-	Wired and figured glass
IS:5491	-	Code of practice for laying of in-situ granolithic concrete floor topping
IS:6041	-	Code of practice construction of autoclaved cellular concrete block masonry
IS:6042	-	Code of practice for construction of light weight concrete block masonry
IS:6248	-	Specification for metal rolling shutters and rolling grilles
IS:7193	-	Specification for glass fibre base coal tar pitch and bitumen felts
IS:7452	-	Specification for hot rolled steel sections for doors, windows and ventilators
IS:8042	-	Specification for white Portland cement
IS:8543	-	Methods of testing plastics
IS:8869	-	Specification for washers for corrugated sheet roofing
IS: 9197	-	Specification for epoxy resin, hardeners and epoxy resin composites for floor topping
IS:9862	-	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
IS:12200	-	Code of practice for provision of waterstops at transverse contraction joints in masonry and concrete dams
BS : 476 (Part – 20)	-	Methods for determination of the fire resistance of elements of construction (General Principles)

BS : 476 (Part – 21)	-	Methods for determination of the fire resistance of load bearing elements of construction
BS : 476 (Part – 22)	-	Methods for determination of the fire resistance of non-load bearing elements of construction
Part – IV	-	National Building code of India (Fire Protection)

8.2 Brickwork

8.2.1 Materials

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

The nominal size of the modular brick shall be 200mmx100mmx100mm with the permissible tolerances over the actual size of 190mmx90mmx90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mmx115mmx75mm with tolerance upto ±3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the items of work.

The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the Engineer for approval and bricks supplied shall conform to approved samples. If demanded by Engineer, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by Engineer shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to IS: 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer. If so directed by the Engineer, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the Engineer. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. Incase, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

The Contractor shall arrange for test on mortar samples if so directed by the Engineer.

8.2.2 Workmanship

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one metre. Brick work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the Engineer.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Engineer. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/pointing.

In the event of usage of traditional bricks of size 230 mm x115mm x75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50mm on either sides of the beam, duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction Drawings are generally required to be provided in the half brick partition walls.

Where the drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

Contractor shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and provide pockets, leaving openings, cutting chases etc. in accordance with the construction

drawings. Miscellaneous inserts shall be either supplied free by the Employer or to be furnished by the Contractor. Any of the miscellaneous inserts which are required to be fabricated and supplied by the Contractor and cement concrete to be provided in the pockets for holdfasts of door/window frames etc. shall however, be measured and paid for separately under the respective items of work.

Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration etc., at all times.

8.2.3 Measurement

Measurement shall be in cu. m correct to two places of decimal for brickwork of thickness one brick i.e. 200 mm/230 mm and above. Measurement shall be in sq. m correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. 100mm/115mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transoms / mullions etc. All concrete works shall be measured and paid for separately under the respective items of work.

8.3 Uncoursed Random Rubble Masonry in Foundation, Plinth and Superstructure

8.3.1 Materials

Stones for the works shall be of the specified variety which is hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS:1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the Engineer for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:6. Materials and preparation of mortar shall be as specified in clause 8.2.1.

8.3.2 Workmanship

For all works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be up to a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq. m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45deg. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in clause 8.2.2.

8.3.3 Measurement

Measurement shall be in cu. m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

8.4 Coursed Rubble Masonry (First Sort) for Superstructure

8.4.1 Materials

The Material specification for the work shall be as per clause 8.3.1.

8.4.2 Workmanship

All courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least 1/3rd the number of stones shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by at least 75 mm.

The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for at least 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

No spalls or pinning's shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stones shall be as specified in clause 8.3.2 with the further stipulation that these shall be provided at 1.5 m to 1.8m apart clear in every course but staggered at alternate courses.

The quoins which shall be of the same height as the course in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 8.2.2.

Requirements of execution of the work and curing shall be as stipulated in clause 8.3.2 .

8.4.3 Measurement

Measurement shall be in cu. m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

8.5 Concrete Block Masonry

8.5.1 Materials

Masonry units of solid concrete blocks shall conform to the requirements of IS : 2185 (Part 1).

Masonry units of solid light-weight concrete blocks shall conform to the requirements of IS : 2185 (Part 2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

Length 400, 500 or 600 mm

Height 100 or 200 mm

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than ±5 mm and maximum variation in height or width of the units shall not be more than ± 3mm.

Concrete blocks shall be of solid blocks and shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of Engineer.

8.5.2 Workmanship

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry, IS:6042 for light weight concrete block masonry and IS:6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 8.2.1.

The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, leveled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.

As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis as per the drawings.

At intersection of walls, the courses shall laid up at the same time with a true masonry bond between atleast 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 8.2 for the brick work.

Curing of the mortar joints shall be carried out for atleast 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 8.2.2 shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

8.5.3 Measurement

Measurement shall be in cu. m. correct up to two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq.m correct upto two places of decimal for walls of 100 mm/150 mm in thickness. Measurement shall be for the quantities as actually executed duly deducting for openings and concrete works. Concrete and reinforcement will be measured and paid for separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

8.6 Damp - Proof Course

8.6.1 Materials and Workmanship

Where specified, all the walls in a building shall be provided with damp-proof course cover plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm down graded coarse aggregates.

The surface of brick work/stone masonry work shall be leveled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for atleast seven days after which it shall be allowed to dry for taking up further work.

8.6.2 Measurement

Measurement of damp-proof course shall be in sq.m correct to two places of decimal as actually executed. No separate payment will be made for formwork.

8.7 Miscellaneous Inserts, Bolts etc.

All the miscellaneous inserts such as bolts, pipes, plate embedment etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction drawings. Contractor shall prepare and use templates for this purpose, if so directed by the Engineer. In the event, of any of the inserts are improperly installed, Contractor shall make necessary arrangements to remove and reinstall at the correct locations/levels, all as directed by the Engineer without any extra cost to the Employer.

8.7 .1 Measurement

Miscellaneous inserts, supplied by the Contractor shall be measured and paid for as per the respective items of work.

8.8 Wood Work in Doors, Windows, Ventilators & Partitions

8.8.1 Materials

Timber to be used shall be first class Teak wood as per IS:4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 8 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS: 2202 (Part 1) and with particle board/hard board face panels shall conform to IS: 2202 (Part 2).

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware for fittings and fixtures shall be of the best quality from approved manufacturers.

8.8.2 Workmanship

The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the detailed drawings and/or as directed by the Engineer.

All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work. The workmanship shall generally conform to the requirements specified in IS:4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door and window frames, one at the centre and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber panelled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the drawings. The stiles and rails shall be joined by mortice and tenon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS: 1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS: 710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, venetian louvre opening, teak wood lipping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS: 710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS: 4020, if so desired by the Engineer.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS: 2835.The thickness and type of glazing to be provided shall be as specified in the item of work.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminium shall be as specified. The number, size and type of the fittings and fixtures shall be as indicated in the drawings/item of work.

Wood work shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the Engineer. The type of finish and the number of coats shall be as stipulated in the respective items of work.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the drawings.

The framework of the partitions with mullions and transomes shall be with the sections of dimensions as specified. Panels of double/single glazing/plywood shall be fixed as per details specified. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the Construction drawings.

Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per Specifications at no extra cost to the Employer.

8.8.3 Measurement

Measurement for doors, windows, ventilators, architraves and partitions shall be in sq.m correct to two places of decimal. Handrailing shall be measured in running metres correct to two places of decimal. Measurement shall be from out to out of the frames. Rates quoted shall be for all the works including glazing, painting, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

8.9 Steel Doors, Windows and Ventilators

8.9.1 Materials

Hot rolled steel sections for the fabrication of steel doors, windows and ventilators shall conform to IS: 7452 which are suitable for single glazing.

Pressed steel door frames for steel flush doors shall be out of 1.25mm thick mild steel sheets of profiles as per IS : 4351.

Transparent sheet glass shall conform to the requirements of IS : 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware of fittings and fixtures shall be of the best quality from the approved manufacturers.

8.9.2 Workmanship

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings. Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS : 1038. Steel windows shall conform to IS : 1361, if so specified.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and mitred. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS : 1038. Tolerance in overall dimensions shall be within ±1.5mm. The frames and shutters shall be free from wrap or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the Engineer before further manufacture/purchase by the Contractor.

Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and / or as shown in the drawings for single or composite units.

For windows with fly proof mesh as per the item of work, rotor operator arrangement, for the operation of the glazed shutters from the inside shall be provided.

Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock-strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as per the requirements of IS : 4351. Pressed steel door frames shall be fixed as `built-in' as the masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side and each course grouted with mortar to ensure solid contact with the door frame, without leaving any voids. Temporary struts across the width shall be fixed, during erection to prevent bow/sag of the frame.

Door shutters of flush welded construction shall be 45mm thick, fabricated with two outer skins of 1.25mm thick steel sheets, 1mm thick steel sheet stiffeners and steel channels on all four edges. Double shutters shall have meeting stile edge bevelled or rebated. Provision of glazed viewing panel, louvers shall be made as per the items of works and/or drawings. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting. Single sheet steel door shutters shall be fabricated out of 1.25mm thick steel sheets, mild steel angles and stiffeners as per the drawings.

Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The dimensions of the masonry opening shall have 10mm clearance all-round the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

Glazing of the units shall be either with flat transparent glass or wired / figured glass of the thickness as specified in the items of works. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or with metal beads. Pre-formed PVC or rubber gaskets shall be provided for fixing the beads with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in drawings.

Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanised with thickness of the zinc coating as stipulated all as described in the respective items of works.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the items of works. The number, size and type of fittings and fixtures shall be as in the Drawings /items of work.

Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081. Necessary holes etc required for fixing shall be made by the Contractor and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

8.9.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames. Rates quoted shall be for the works including glazing, painting, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

8.10 Aluminium Doors, Windows, Ventilators & Partitions

8.10.1 Materials

Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS:733.

Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.

Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

8.10.2 Workmanship

All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminum windows, shall conform to IS:1949, if so specified.

All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within ± 1.5mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminium swing type doors, aluminum sliding windows, partitions shall be as described in the items of work / drawings.

IS:1948 and IS:1949 refers to incorporating the sizes, shapes, thicknesses and weight per running metre of extruded sections for various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor, will be reviewed by the Engineer and will be accepted only if they are equal to or marginally more than that given in the codes / specified in the items of work.

The framework of the partitions with mullions and transomes shall be with anodised aluminium box sections. Anodised aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawings. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.

Specific provisions as stipulated for steel doors, windows, ventilators under clause 8.9.2 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

8.10.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out of the frames. Rate quoted shall be for the works including glazing, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

8.11 Steel Rolling Shutters

8.11.1 Materials and Workmanship

Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS: 6248.

The type of rolling shutter shall be self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the drawings.

Shutters shall be built up of interlocking laths 75 mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS:6248 for various clear widths of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.

Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of work.

In case of galvanized rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating per sq.m shall be as specified in the items of work.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

8.11.2 Measurement

Measurement shall be in sq.m correct to two places of decimal of the clear area of the opening. Quoted rate shall be inclusive of painting as specified in the item of work.

8.12 Rubble Sub-Base

8.12.1 Materials

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ± 10 mm. Stones shall not have a base area neither less than 250 sq cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the Engineer.

8.12.2 Workmanship

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

8.12.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

8.13 Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in items of work.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

8.13.1 Measurement

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

8.14 Terrazzo and Plain Cement Tiling Work

8.14.1 Materials

Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS: 1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than $14N/mm^2$.

The type, quality, size, thickness colour etc, of the tiles for flooring/dado/skirting shall be as specified in the items of work.

The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary Portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm upto 6mm or from 1mm upto 12mm. This shall be 6mm for tiles with chips varying from 1mm upto 25mm. The minimum thickness of wearing layer of cement/coloured cement tiles shall be 5mm. This shall be 6mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix.

8.14.2 Workmanship

Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS:1443.

Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.

The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

A layer of 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS:2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.

Neat cement slurry using 4.4 kg of cement per sq.m of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the matrix of the tile. For this purpose white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.

About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those

laid earlier, it is necessary that the Contractor shall procure sufficient quantity of extra tiles to meet this contingency.

Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish. Contractor shall note that the unit rate quoted for skirting shall also include for any chipping of the brickwork required to be carried out for this item.

Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

Machine grinding and polishing shall be commenced only after a lapse of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS:1443.

Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localized deviation of ±3mm in any 3m length is acceptable in a nominally flat floor.

8.14.3 Measurement

Measurement for floor tiling and dado shall be in sq. m correct to two places of decimal. Actual quantity of tiling work as laid shall be measured for payment as per the respective items of work after making deductions for openings etc. Measurement for skirting shall be in running metres correct to two places of decimal for the specified height as per the item of work.

8.15 In-Situ Terrazzo Work

8.15.1 Materials

The requirements of marble aggregates for terrazzo topping shall be as per clause 8.14.1.

Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement working to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

8.15.2 Workmanship

The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado/ skirting shall be as specified in the respective items of works. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS: 2114.

In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The underlayer shall be of cement concrete of mix 1:2:4 using 10mm down graded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than 10mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

Both the under layer and later the topping shall be divided into panels not exceeding 2 sq.m for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividing strips are

not provided, the bays shall be laid alternately, allowing an interval of atleast 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminium, brass or other material as indicated in the items of works. Aluminum strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work.

Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreading the underlayer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided shall be fixed on the base and levelled to the correct height to suit the thickness of the finish. Just before spreading the underlayer the surface shall be smeared with cement slurry at 2.75 Kg/sq.m. Over this slurry, the underlayer shall be spread and levelled with a screening board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo topping shall be laid while the underlayer is still plastic and normally between 18 to 24 hours after the underlayer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of troweling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

Machine grinding and polishing shall be commenced only after a lapse of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS: 2114.

8.15.3 Measurement

Measurement shall be as per clause 8.14.3.

8.16 Shahabad / Tandur/ Kota Stone Slab/ Granite flooring work

8.16.1 Materials

The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS : 1124.

The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be ±5mm. This shall be ±2mm on dimensions less than 100mm.

Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

8.16.2 Workmanship

The type, size, thickness and colour/shade etc. of the slabs for flooring/dado/skirting shall be as specified in the respective items of work.

Preparation of the concrete base, laying and curing shall be as per clause 8.14.2.

Dado / skirting work shall be as per clause 8.14.2. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

Grinding and polishing shall be as per clause 8.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not be applied before polishing.

8.16.3 Measurement

Measurement shall be as per clause 8.14.3.

8.17 Carborundum Tile Finish

8.17.1 Materials

Carborundum tiles shall generally conform in all respects to the standards stipulated in IS:1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm^2.

The topping shall be uniform and of thickness not less than 6mm. The quantity of carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60 mm mesh.

The size, thickness, colour and plain or chequered etc of the tiles for flooring / skirting shall be as specified in the respective items of work.

8.17.2 Workmanship

Requirements as detailed for terrazzo/cement tile finish under clause 8.14.2 shall be applicable for carborundum tile flooring.

8.17.3 Measurement

Measurement shall be as per clause 8.14.3.

8.18 Glazed Tile Finish

8.18.1 Materials

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

8.18.2 Workmanship

The size, thickness, colour, with or without designs etc of the tiles for flooring/dado/skirting shall be as specified in the respective items of work.

The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5.

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

Colored tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

Neat cement slurry using 3.3 kg cement per sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

All the joints shall be cleaned of grey cement with wire brush to a depth of atleast 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

Specials consisting of coves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

8.18.3 Measurement

Measurement shall be as per Clause 8.14.3.In-Situ Cement Concrete Floor Topping

8.18.4 Materials

The mix proportion for the in-situ concrete floor topping shall be 1:2.5:3.5 (one part cement: two and half parts sand: three and half parts coarse aggregates) by volume unless otherwise specified in the items of work.

The aggregates shall conform for the requirements of IS: 383.

Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing valve shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS: 2571.

Grading of the sand shall be within the limits indicated in IS: 2571.

8.18.5 Workmanship

The thickness of the floor topping shall be as specified in the items of work. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per clause 8.13. The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.

Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of atleast one day. Construction joints shall be plain vertical butt joints.

Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities and these shall be made good immediately.

Finishing of the surface by troweling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be re- trowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerances is achievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finish which are difficult to repair satisfactorily.

8.18.6 Measurement

Measurement shall be in sq.m correct upto two places of decimal.

8.19 In-Situ Granolithic Concrete Floor Topping

8.19.1 Materials and Workmanship

The requirements of materials and workmanship shall be all as per clause 8.19 for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement:sand:coarse aggregates) by volume.

The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

8.19.2 Measurement

Measurement shall be in sq.m correct upto two places of decimal.

8.20 Floor Hardener Topping

8.20.1 Materials & Workmanship

Floor hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid monolithically with the concrete/granolithic floor finish on top of hardened concrete base.

Floor hardener of the metallic or non-metallic type suitable for the performance of normal / medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work.

For monolithic application with the floor finish/slab the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screened and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 8.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 10 days.

The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

8.20.2 Measurement

Measurement shall be in sq.m correct to two places of decimal. This could be either separate or combined along with the floor finish as indicated in the respective items of work.

8.21 PVC Sheet/Tile Flooring

8.21.1 Materials

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS: 3462 or homogeneous PVC asbestos tiles conforming to IS:3461.

The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS. Contractor shall submit the test certificates, if so desired by the Engineer.

Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark, and batch number.

The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/tiles.

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work.

8.21.2 Workmanship

PVC floor covering shall be provided over an underbed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the underbed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS: 5318.

The surface of the underbed shall have trowelled finish without any irregularities which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the underbed until the A/C units have been in operation for atleast 7 days. During this period, the temperature range shall be between 20deg.C and 30deg.C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout.

The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slided on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

8.21.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. The item could be either separate or as a combined item with the floor finish as specified in the respective items of work.

8.22 Acid Resisting Brick/Tiling Work

8.22.1 Materials

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS: 4457. Acid resistant bricks shall conform to the requirements of IS: 4860.

The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.

The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS: 4832 (Part II). Method of usage shall generally be as per the requirements of IS: 4443.

8.22.2 Workmanship

The size and thickness of tiles/size and class of bricks for use in the flooring/skirting/dado shall be as specified in the respective items of work.

The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS:3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS:1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into

the bed and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.

The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

8.22.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for flooring/dado. Measurement shall be in running metres correct to two places of decimal for skirting of height as specified in the item of work.

8.23 Heavy Duty Abrasion Resistant Flooring

The type, quality, size, thickness, colour, etc., of the tile for flooring and skirting work shall be of the best quality approved by the Engineer. For this purpose, the Contractor shall provide the Engineer with necessary samples for this selection. Tiles shall be hardwearing, resistant to impact, resistant to abrasion, free from slipperiness and also resistant to attack by water, oils and greases.

8.24 Epoxy Lining Work

8.24.1 Materials

The epoxy resin and hardener formulation for laying of jointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS: 9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

a) Hydrochloric acid upto 30% concentration

b) Sodium hydroxide upto 50% concentration

c) Liquid temperature upto 60deg.C

d) Ultraviolet radiation

e) Alternate wetting and drying

Sand shall conform to grading zone III or IV of IS: 383.

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the Engineer.

8.24.2 Workmanship

The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.

Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

8.24.3 Measurement

Measurement shall be in sq.m correct to two places of decimal.

8.25 Water-Proofing

Machine made flat Yelahanka tiles shall be of the size and thickness as specified in the item of work. Tiles shall be soaked in water for atleast one hour before laying. The tiles shall be laid on a mortar bed of cement mortar 1:3 with an average thickness of 25mm. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and to set to plane surface true to slope, using trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction on run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by atleast 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:3 mixed with red-oxide. Curing shall be carried out for a minimum period of seven days.

8.25.1 General

The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Engineer.

The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The brick bat coba shall be covered as specified below.

The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the Engineer.

8.25.2 Modified Bituminous Membrane

Modified Bituminous Membrane shall be “SUPER THERMOLAY” 4 mm thick weighing 4 Kg/sqm, manufactured using APP Polymer modified bitumen with a central core of non-woven polyester reinforcement (200 gms/sqm) and with top and bottom layers of thermofusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumat Company Limited. “PLYFLEX” of Bitumat Company Limited, Saudi Arabia supplied by STP Limited shall also be acceptable or other equivalent specification.

8.25.3 Waterproofing of Roofs with Lime Concrete

8.25.3.1Materials

Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25mm and shall generally conform to IS:3068.

Lime shall be class C lime (fat lime) or factory made hydrated lime conforming to IS:712.

8.25.3.2Workmanship

Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 1/2 (two and a half) parts of brick aggregates to 1 part of slaked lime by volume. Water shall be added just adequate to obtain the desired workability for laying. Washing soap and alum shall be dissolved in the water to be used. The quantity of these materials required per cum of lime concrete shall be 12kg of washing soap and 4kg of alum. Brick aggregates shall be soaked thoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing.

The roof surface over which the water-proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS: 3067.

The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer or otherwise as indicated in the drawings.

The average thickness of lime concrete, slope and the finish on top of machine made burnt clay flat terracing tiles conforming to IS:2690 (part I) shall be as specified in the items of work. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the items of work, duly considering the traffic the terrace will be subjected to.

The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not be less than 100mm. In case, the thickness is more than 100mm, it shall be laid in layers not exceeding 100mm to 125mm.

Laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards centre and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points.

Lime concrete fillet for a minimum height of 150mm shall be provided all along the junction of the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished on top with provision of clay terracing tiles/cement concrete tiles.

After the lime concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done using wooden THAPIES with rounded edges. The beating will normally have to be carried on for at least seven days until the THAPI makes no impression on the surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column projections.

During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothened with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the Engineer.

a) By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 litres of water.

b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small pieces and allowed to soak in water), 200 gm of jaggery and 40 litres of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.

The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously.

Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before laying. Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles

to the direction of run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by atleast 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instructions. Curing shall be carried out for a minimum period of seven days.

Finishing on top with cement concrete tiles or in-situ cement concrete floor topping shall be carried out in similar fashion as described for clay tiles in above the paragraph. Tiles to be used shall be supplied after the first machine grinding of the surface.

8.25.4 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the plan area where the treatment is executed. No separate payment shall be made for the fillets.

8.25.5 Waterproofing of Roofs/Terraces etc.

8.25.5.1Water proofing of Horizontal Surfaces

The waterproofing shall be applied as follows:

A coat of Blown Bitumen 85/25 shall be applied at the rate of 1.45 kg/sq.km

A roll of Modified Bituminous Membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller. Torching shall be done, where recommended by the manufacturer and where directed by the Engineer-in-Charge, as the unrolling progresses.

The side overlaps shall be minimum 100 mm whereas the end overlaps shall be minimum 150 mm; both shall be bonded and sealed by flame torching.

Care shall be taken that the membrane is lapped with the treatment along the vertical surface and roof gutter treatment for at least 500 mm.

The membrane shall be properly overlapped/terminated at all openings, rainwater downtakes etc. to ensure that such junctions do not become sources of leakage.

Top of membrane finally shall be painted with antiglouse reflective paint.

8.25.5.2Waterproofing of Vertical Surfaces at Roof Level and Gutters

The Water proofing shall be applied as described in (a) above.

Modified Bituminous membrane shall be unrolled and bonded to the substrate after applying a coat of bitumen and by pressing down evenly for the full width of the roll. Light torching shall be done to ensure complete bonding.

The membrane shall be overlapped with treatment for the horizontal surface by at least 500 mm.

The membrane shall be taken upto a pre-cut chase anchored and sealed.

8.25.6 Khurras and Rainwater Down Pipes

Down pipes shall be isolated from RCC work with 6 mm polyethylene foam fixed with adhesive (Araldite) and sealed with silicone sealant prior to laying membrane. A water proofing flashing composed of one layer of Hessian based self finished felt Type 3 Grade 1 and two layers of aluminium foil of 0.075 mm thickness shall be provided. This flashing shall be carried into the down take pipes for at least 150 mm and sealed with hot bitumen. The Contractor shall closely coordinate the work with the agency providing and fixing the rainwater down take pipes.

8.25.7 Testing

The treated area (flat and horizontal only) shall be tested by allowed water to stand on the treated areas to a depth of 150 mm for a minimum period of 72 hours.

The treated area (flat and horizontal) shall have continuous slope towards the rainwater outlets and no water shall pond any where on the surface.

8.26 Cement Plastering Work

8.26.1 Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. If so desired by the Engineer sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30

minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re- tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

8.26.2 Workmanship

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Engineer.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in above paragraph.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the

second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats. The first coat shall be approximately 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the Engineer duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the Engineer.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturers instruction while preparing the cement mortar.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 8.2.2.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement.

c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

8.26.3 Measurement

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

8.27 Cement Pointing

8.27.1 Materials

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and

organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer and if so directed it shall be washed/screened to meet specification requirements.

8.27.2 Workmanship

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for atleast 7 days after the pointing is completed. Whenever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Engineer.

8.27.3 Measurement

The quantity of work to be paid for under this item shall be measured in sq.m. Correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

8.28 Metal Lath and Wire Fabric

8.28.1 Materials

Welded steel wire fabric shall conform to IS: 4948.

Expanded metal shall conform to IS: 412.

Galvanised wire mesh shall be of approved quality.

8.28.2 Workmanship

The type and details of the steel material to be used for metal lath plastering work and at the junctions of brick masonry/concrete before wall plastering shall be as specified in the respective items of work.

For metal lath plastering work, the weight of steel material shall be not less than 1.6 kg/sq.m.

Steel material for use at the junction of brick masonry/concrete shall have the mesh dimensions not greater than 50 mm.

Steel material shall be obtained in maximum lengths as manufactured to restrict joints to the minimum. Overlap at the joints shall be minimum 25 mm which shall be securely tied with wires of diameter not less than 1.25 mm at spacings not more than 100 mm for lath plastering work. Nailing to wall shall be at spacings not exceeding 200 mm. The material shall be straightened, cut and bent to shape if required for fixing as per the details indicated in the drawings.

8.28.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the type as specified in the respective items of work.

8.29 Water-Proofing Admixtures

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer.

8.30 Painting of Concrete, Masonry & Plastered Surfaces

8.30.1 Materials

Oil bound distemper shall conform to IS: 428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint.

Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.

White wash shall be made from good quality fat lime conforming to IS: 712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cum of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the Engineer.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

8.30.2 Workmanship

Contractor shall obtain the approval of the Engineer regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata.

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

8.30.3 White Wash

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified. The dry surface shall present a uniform finish without any brush marks.

8.30.4 Colour Wash

Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied unless otherwise specified. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

8.30.5 Cement Paint

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 2 coats of the same colour shall be applied. Atleast 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for atleast 2 days after the application of final coat. The operations for brushing each coat shall be as detailed above.

8.30.6 Oil bound Distemper

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for atleast 48 hours. A minimum of two coats of oil bound distemper shall be applied, unless otherwise specified. The first coat shall be of a lighter tint. Atleast 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

8.30.7 Acid, Alkali Resisting Paint

A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

8.30.8 Plastic Emulsion Paint

The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paint shall be laid on evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly

in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied unless otherwise specified. Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.

8.30.9 Acrylic Emulsion Paint

Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified.

8.30.10 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter's cradle etc.

8.31 Painting & Polishing of Wood Work

8.31.1 Materials

Wood primer shall conform to IS: 3536.

Filler shall conform to IS: 110.

Varnish shall conform to IS: 337.

French polish shall conform to IS: 348.

Synthetic enamel paint shall conform to IS: 2932.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

8.31.2 Workmanship

The type of finish to be provided for woodwork of painting or polishing, the number of coats, etc. shall be as specified in the respective items of work to be prepared by the Contractor.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS: 2338 (Part I).

All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work to be prepared by the Contractor. Any slight irregularities of the surface shall then be made- up by applying an optimum coat of filler conforming to IS: 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. Atleast 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Employer's Representative. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off. Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS:337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the Employer's Representative. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flatting varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The

finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

8.32 Painting of Steel Work

8.32.1 Materials

Red-oxide – zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932.

Aluminium paint shall conform to IS: 2339.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

8.32.2 Workmanship

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS: 1477 (Part 2).

The type of paint, number of coats etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part – I) and as indicated in the item of work.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from `holidays'.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall

be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

Atleast 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Employer's Representative.

8.33 Flashing

3.24.1 Materials

Anodised Aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

Bitumen felt shall be either Hessian base self finished bitumen felt Type-3 Grade I conforming to IS:1322 or glass fibre base self finished felt Type-2 Grade 1 conforming to IS:7193.

8.33.1 Workmanship

The type of the flashing and method of fixing shall be as specified.

Flashing shall be of the correct shape and size as indicated in the construction drawings and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.

Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/concrete along with cement mortar 1:4 filletting as indicated in the Drawings. Curing of the mortar shall be carried out for a minimum period of 4 days.

Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 litre/sq.m after the installation.

8.33.2 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the actual area of the flashing material provided and the rate shall include for all the incidental works of bending to shape and fixing details as per the construction drawings.

8.34 Thermal Insulation for Ceiling

Thermal insulation shall be "Thermocole" TF type or similar approved or Resin bonded fibre glass boards.

8.34.1 Fixing

8.34.2 "Thermocole" Boards

Soffit of R.C. slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 Kg/m^2.

Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen.

The boards shall be further secured with screws, washers and plugs.

The joints of the boards shall be sealed with bitumen.

8.34.3 Fibre Glass Boards

Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centres with 6mm x 65mm long wood screws. 20 gauge G.I. lacing wire shall be tied to the pegs.

`Crown' 200 fiberglass boards 50mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.

The insulation boards shall be covered with 20mm – 24 gauge hexagonal G.I. chicken wire mesh, nailed to the timber pegs and 30 gauge aluminium sheets shall be fixed over the chicken wire mesh with 50mm overlap and secured to the timer pegs by screws.

If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the framework. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

8.34.4 Measurement

The net superficial area of the insulation shall be measured and paid for.

8.35 Plaster of Paris Board False Ceiling

8.35.1 Plaster of Paris Boards

The plaster of paris boards to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by Engineer.

The plaster of paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent sulphur trioxide and other requirements as per IS:2547 (Part I) However, its fineness shall be such that the residue, after drying, and sieving on I.S. sieve designation 3.35mm for 5 minutes shall not be more than 1 percent by weight. Initial setting time shall not be less than 13 minutes. The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 kg per sq.cm.

The plaster of paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizes as shown on the drawings or as directed by the Engineer. Wooden forms of height equal to the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet. The edges of the boards shall be truly square. The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non-staining oil to facilitate the easy removal of the board. Plaster of paris shall be evenly spread into the form upto about half the depth and hessian cloth or coir shall be pressed over the plaster of paris layer. The weight of hessian cloth or coir in the board shall be 250 gm per sq.m. The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm. The hessian cloth shall be of an open web texture so as to allow the plaster below and above to intermix with each other and form an integral board. The form shall then be filled with plaster of paris which shall be uniform pressed and then wire cut to an even and smooth surface. The board shall then be allowed to set initially for an hour or so and then removed from the form and allowed to dry and harden for about a week. The board after drying and hardening shall give a ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.

The size of boards shall generally be 600mm x 600 mm x 12 mm thick. Boards shall be kept dry in transit and stored flat in a clean dry place and shall not be exposed to moisture. The boards shall always be carried on edges.

8.35.2 Metal Framework

The metal frame work may be made of sections of light metal, such as anodised aluminium, mild steel or as shown on the drawings. The shape of cross-section shall be such as to facilitate proper suspension and proper fixing of the ceiling boards covering them and shall be structurally sound and rigid.

8.36 Construction

Contractor shall ensure that the frame to support the ceiling is designed for structural strength and the sizes, weight and strength of ceiling boards to be fixed and other loads due to live load, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shown on the drawings. Contractor shall also submit a detailed drawing to show the grid work, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access doors, etc.

The false ceiling grid work shall be carried out as per the approved drawings or as directed by Engineer. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at 1.2m centre to centre and secondary runners of size 50mm deep x 40 mm wide at 60mm centre to centre perpendicular to the main runners.

The metal frame work when it is anodised aluminium false ceiling grid system shall consist of aluminium main member of special T-Profile of 38mm x 38mm x 1.5mm thick, interlocking with each other to form frames of various sizes, 600mm x 600 mm or as shown on the drawing. The main members shall be suspended from the roof structures by means of steel hangers as described for timber frame work and supported at the walls by means of anodised aluminium wall angles.

In the case of timber frame work, all the edges of the plaster of paris board shall be fixed to frame members by means of counter sunk and rustless screws of 2.74 mm size, 40mm long at a spacing of 100mm to 150 mm c/c and 12mm from the edge of the board. Holes for screws shall be drilled and screws slightly countersunk into the boards. The boards shall be fixed to wooden framework with a joint clearance of about 3mm. The joints shall always be in perfect line and plane.

In case of aluminium grid system, boards shall be just placed into the frames formed by the main `T' members and the cross members fitted with the clips for locking boards. Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joint. The boards shall be cut with a saw, if required, to any shape and size.

As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting, Contractor shall fully co-operate with the other agencies entrusted with the above work, who may be working simultaneously. Contractor shall provide necessary openings in the false ceiling work for air-conditioning, lighting and other fixtures. Additional framing, if required, for the above opening shall also be provided at no extra cost to the Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by the Engineer.

8.36.1 Finishing

It is essential that false ceiling work should be firm and in perfect line and level and all boards free from distortion, bulge, and other defects. All defective boards and other material shall be removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of Engineer.

The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints for aluminium frame work shall be of inter-locking type so that when the cross member is in place, it cannot be lifted out.

The countersunk heads of screws and all joints shall be filled with plaster of paris and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50mm wide on either side of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 10mm wide. If metal scrim is used, a stiffer plaster will be necessary to enable the trowelling of the scrim down to the board.

8.36.2 Fire Stopping

In case of fire protective ceilings, fire resisting barriers at suitable intervals shall be provided. These shall completely close the gap between the false ceiling and soffit of the structural slab. The material of the barrier shall be as indicated by Engineer (Reference may be made to the British Standards Institutions CP 290: Code of Practice for suspended ceiling and lining of dry construction using metal fixing system, `for guidance).

8.36.3 Measurement and Payment

The superficial area of false ceiling shall be measured and paid for at the unit rate less deductions, if any. Openings in false ceiling which are less than 0.4 sq.m. in area shall not be deducted for the purpose of payment.

The quoted rates shall include supply, delivery and erection of all materials for covering the ceiling, frame work suspenders or hangers, anti-termite treatment making openings in false ceiling, extra frame work required for the openings, supporting the main members on masonry walls, levelling and finishing complete.

Where moulding or beading is specified, it shall be as per details shown in drawings and shall be measured in running metres and paid for separately.

Where fire barriers are specified, they shall be as per details shown in drawings and as directed and shall be measured in square metres and paid for separately.

8.37 False or Cavity Floor

8.37.1 Frame Work

The false floor shall consist of a framework of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600mm centre to centre in both directions. The stools shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead. The above framework shall be suitably designed to accommodate 35mm thick, 600mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm dia. anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.

The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities upto plus or minus 15mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the propheads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

8.37.2 Floor Panels

The floor panels shall be made of 600mm x 600mm x 35 mm thick medium density unveneered/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cum bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS: 3087-specification for wood particle boards (Medium Density) for general purposes.

The thermal conductivity of the boards shall not exceed 0.12 k Cal/hr/sq.m/deg./C/m.

The panel size given above may be suitably modified near electrical panel/equipment and also to suit room dimensions with panel size not more than 600mm under any circumstances. Exposed 2mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat or primer and two coats of approved fire resistant paint from underside.

The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 and of approved colour and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the supporting framework. Each floor panel shall be marked on the inner side with stickers for easy identification and reassembly whenever required.

Suitable backing material shall be provided on the underside of the particle board to prevent warping and / or to cater to specified loading.

Suitable removable covers shall be provided to serve as outlets for the cables.

8.37.3 Finished Height of False Flooring

The finished height from top of reinforced concrete floor to the finished floor surface of false/cavity floor shall be as specified or as shown on drawings.

8.37.4 Ramps and Steps

Ramps and steps shall be provided as shown on the Engineer's drawing and as directed by the Engineer without any extra cost to the Employer.

8.37.5 Imposed Loading

The finished floor shall be capable of supporting uniformly distributed loads of 500 to 1000 Kg. per sq.metre of floor area as specified in data sheet. A point load of 450 Kg on 600 sq.mm on any part of the panel or a line load of 725 Kg on 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

8.37.6 Finish

The finished floor shall be true to lines and levels and present a neat flush surface.

8.37.7 General

Supply shall be made by a specialist supplier who is to be approved by Engineer. Supplier shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, supplier shall also submit his calculations for the supporting system with all relevant data assumed, to the Engineer for his approval. Work shall be carried out on approved drawings only.

8.37.8 Measurement

The superficial area of false floor shall be measured and paid for at the quoted unit rate.

8.37.9 Vendor Drawing

Vendor shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, vendor shall also submit his calculations for the supporting system with all relevant data assumed, to the Employer's Representative for his approval. Work shall be carried out on approved drawings only.

8.38 Fire Proof Doors

8.38.1 Material and Workmanship

The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire. The materials, fabrication and erection of fire proof doors shall confirm to IS: 3614 (Part – I). The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. Sample approval shall also be obtained from testing authority as per the standard IS: 3614 (Part – 2) for the specified degree of fire rating in hours. All fire proof doors shall have specified sizes and confirm to the description in the respective items of work.

Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS: 6687) or stainless steel (conforming to IS: 304) sheet (18G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wool in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter shall not be less than 35mm for two hour fire rating and 46 mm for four hour fire rating.

The shutter with the required insulating material shall be mounted on angle iron frame or the special made frame from zinc coated (16G minimum) weldable steel sheet. The shutter shall be fixed to frame by means of suitable hinges and shall have a three way latching system. All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating. All other accessories like hinges, door lock, hold fasts, etc. shall be provided as approved by TAC (Tariff Advisory Committee). All these accessories shall be compatible with the material used for door and shutter.

8.39 Handrail

All hand railing shall be provided with Aluminum Extrusion tubes having alloy AA6082 Temper T6 or AA 6063 T6 with an ultimate tensile strength of at least 207 MPa and yield strength of at least 172 MPa. The minimum height of hand railing shall be 1m and maximum spacing of verticals shall be 1.5 m- Number of horizontal rails shall be 3 with a 100mm x 2.5mm toe plate at the bottom.

Top Rail shall be from 32NB (42.16 mm OD) tube of schedule 40(3.50mm thk) , while 2 no of mid rail shall be of 25NB (33.4mm OD) Schedule 40 tube. Post tube shall be 32NB (42.16mm OD) Schedule 80 (4.80mm thk min). Toe guard of min 100mm height & having sufficient rigidity extruded out of min 2.5mm Thk alloy AA 6063 Temper T6.

welding not allowed for fabrication of handrails. Assembly and fabrication of Handrail shall be done by using Structural Fittings, manufactured from Aluminium Alloy 356/LM 25 with heat treatment (min UTS of alloy -280 N/mm2) confirming to ASTM B 108, ASTM B 26/ BS 1490. Aluminium Structural fittings shall be dynamically tested for permissible deflections while applying 74 kg / Linear Meter of UDL & 90 kg point load as per methodology mentioned in ASTM E 935.

Handrail shall be fixed on RCC surface with Mechanical or Chemical Anchor fasteners and shall be of SS or HDG and all fittings and pipes shall be prefinished as per IS 1868. The drawings to be submitted to the engineer for approval.

Hand railing on the top tier of the SBR shall be 2.0m height. Top Rail shall be from 32NB (42.16 mm OD) tube of schedule 40(3.50mm thk) , while 2 no of mid rail shall be of 25NB (33.4mm OD) Schedule 40 tube. Post tube shall be 32NB (42.16mm OD) Schedule 80 (4.80mm thk min). Toe guard of min 100mm height & having sufficient rigidity extruded out of min 2.5mm Thk alloy AA 6063 Temper T6.

8.40 Gratings & chequered plates

All Gratings and Chequered plates used in the STP shall be of aluminium and as approved by the Engineer.

8.41 Aluminium Mesh/Grill

The clear space between the ground floor SBR tank and bottom of Top tier SBR tank , which is about 4.50m(min) shall be covered with Aluminium mesh or grill with 8mm thick size between the extruded angles min 50x50x8 size @ 1.50m spacing both vertical and horizontal.

End of Section-8

SECTION 9

WELL SINKING

SECTION 9

WELL SINKING

9.1 General

Well sinking shall be proposed for Wetwell, in water logged conditions or water table near FGL.

9.2 Earthwork in Excavation

The earthwork shall be in accordance with Section 3. The safety measures to be taken for excavations for open foundations shall be as per guidance laid down in IS 3764.

9.3 Well Sinking

The Construction and sinking of well shall in general follow provisions of IRC 78-2014- Section VII – Foundations and substructure. The latest editions of this code of practice including all applicable official amendments and revision shall be followed. In case of discrepancy between this specification and that referred in code, the specifications will govern.

9.3.1 Setting Out

Necessary reference points shall be fixed, away from the zone of blow-ups or possible settlements resulting from well sinking operations. These reference points shall be connected to the permanent stations with the base line on the banks. The centre of the individual wells shall be marked with reference to these stations.

9.3.2 Equipment

The following equipments are generally used for the work

(a) Crane with grab buckets - capacity 0.5 to 2.0 cum
(b) Chisels of appropriate sizes
(c) Aqua header for cutting rocky strata
(d) Diving helmets and accessories

(e) Equipment for concrete production, transportation, placing & compaction

9.3.3 Cutting Edge

The mild steel cutting edge shall be made from structural steel section with weight not less than 40 kg/m length and properly anchored into the well curb. The parts of cutting edge shall be erected on level firm ground. Temporary support shall be provided to facilitate erection and maintaining the assembly in true shape. The fabrication may be carried out in the shop or at site. Steel sections shall not be heated and forced into shape. However "V" cuts may be made in the horizontal portion, uniformly throughout the length, to facilitate cold bending. After bending such 'V' cuts should be closed by welding. Joints in the lengths of structural sections, unless otherwise specified shall be fillet welded using single cover plate to ensure the requisite strength of the original section. The cutting edge must be suitably stiffened using plate stiffeners spaced at not more than 1.5m c/c along the periphery of cutting edge. The adequacy of the strength and the efficiency of performance of cutting edge shall be specifically checked by Contractor and necessary alterations made if required at his own responsibility. The weight of stiffeners shall not be considered in weight of cutting edge.

9.3.4 Well Curb

Well curb shall be of cast-in-situ concrete. The outer face of the curb shall be vertical. The bottom ends of vertical bond rods of steining shall be fixed securely to the cutting edge with check nuts or by welds. The form work on outer face of curb may be removed within 24 hrs after concreting. The form work of inner face shall be removed after 72 hrs. All the concreting in the well curb shall be done in one continuous operation. The curbs should be cast truly in position and if construction of any cofferdam is required, it shall be done by the Contractor at his own cost.

9.4 Well Steining

The dimensions, shape, concrete strength and reinforcements of the well shall strictly conform to those shown in the drawings. The form work shall preferably be of M.S. sheets shaped and stiffened suitably. In case timber forms are used, they shall be lined with plywood or M.S. sheets.

Steining built in the first lift above the well curb shall not be more than 2 meters. For stability, the first lift of steining shall be cast only after sinking the curb partially. Concreting of steining may be carried out in subsequent lifts of about 2 meters. Attempts should be made to minimise the number of construction joints. The construction joints details shall be as shown in drawing and the receiving surfaces of construction joint shall thoroughly be cleaned and prepared using air and water jets before the

next lift is poured. The concreting layers shall be limited to about 450 mm restricting the free fall of concrete to not more than 2 m. Laitance formed at the top surface of a lift shall be removed to expose coarse aggregates before setting of concrete at the proposed construction joint. As far as possible, construction joints shall not be kept at the location of laps in the vertical steining bars.

The steining of the well shall be built in one straight line from bottom to top such that if the well is tilted, the next lift of steining will be aligned in the direction of the tilt. The work will be checked carefully with the aid of straight edges of lengths approved by the Engineer. Plumb bob or spirit level shall not be used for alignment. After sinking of a stage is complete, damaged portions, if any, of steining at top of the previous stage shall be properly repaired before constructing the next stage.

The height of steining shall be calibrated by making at least 4 gauges (preferably in direction along centre line of bridge and in a direction normal to the centre line of bridge) distributed equally on the outer periphery of the well each in the form of a 100 mm wide strip painted (preferably red colour) on the well, with every half a meter mark shown in black paint (mark thickness shall be 5mm). The gauges shall start with zero at the bottom of the cutting edge. Marking of the gauges shall be done carefully with a steel tape.

After reaching the founding level, the well steining shall be inspected to check for any damage or cracks. The Engineer will direct and the Contractor shall execute the remedial measures before acceptance of the well steining. In case the well cannot be accepted even with any remedial measures, then the well shall stand rejected.

Sinking of well should not be started till the steining has cured for atleast 48hrs. The curing of well shall be continued upto 14 days from the day of concreting. The curing can be by means of water or any approved curing compound.

Any honey combed portion and leakage observed in the steining shall be repaired at Contractor's own cost to the satisfaction of Engineer.

9.4.1 Bottom Plug

The concrete mix shall be designed (in dry condition) to attain the concrete strength as mentioned in drawing, and shall contain 10% more cement content than that required for the same mix placed dry, to cater for under water concreting. However, the total cement content shall not be less than 360 kg/cum of concrete with a slump in the range of 150 mm to 200 mm. Admixture may be added to concrete to impart the required strength. The water cement ratio shall not exceed 0.5 and the slump of concrete shall be minimum 150mm. The diameter of tremie pipe shall not be less than 200 mm.

Concrete for the bottom plug shall be laid by Tremie pipe method. Tremie concrete once started shall be continued without interruption for full concreting in the bottom plug. Before commencing plugging, all loose material from the bottom of the well shall be removed and the inside faces cleaned thoroughly.

Concreting shall be done in one continuous operation till the dredge hole is filled upto the required height and thereafter sounding shall be taken to ensure that the concrete has been laid to the required height.

Least disturbance shall be caused to the water inside the well while laying concrete in the bottom plug and concrete shall not be disturbed in any way for atleast 14 days. To check any rise in the level of bottom plug, soundings should be taken at the close of concreting and once every day for the subsequent 3 days.

The soundness of bottom plug should be tested by de-watering the well by 5 meters below the surrounding water level and checking the rise of water. The rate of rise shall preferably be less than 10 cm per hour. In case rate is higher, remedial measures as directed by Engineer should be taken by contractor at his own cost. The depth of sump below cutting for bottom plugging shall be $1/6^{th}$ the diameter of well. The contractor shall take permission from Engineer before commencing the bottom plug. All necessary inspections like study of strata at founding level, tilt, shift etc. shall be communicated to Engineer before bottom plugging. If any leakage of water is found, then necessary grouting of the plug and the junction of the well to control the same shall be carried out by contractor at no extra cost.

9.4.2 Sand Filling

Sand filling should be commenced after 14 days of laying of bottom plug. The height of bottom plug shall be rectified before starting sand filling. The sand should be clean and free from earth, clay, clods, roots, boulders, shingles etc. and should be backfilled in layers and consolidated by flooding.

9.4.3 Well Cap

The form work for well cap should be prepared conforming to the shape of well cap, concreting should be carried out in dry condition. The bond rods of steining shall be properly anchored into the well cap.

9.5 Sinking of Well

Generally, the cutting edge is fabricated and connected to the concrete well curb. On top of the well curb, adequate height of well steining is cast and the process of sinking is carried out. After a portion of the

well has been sunk, another height of well steining is cast on top of previous section and further sinking carried out. The process is continued till the bottom level of cutting edge reaches the founding level.

The sinking of the well with use of kentledge shall be commenced only after the steining has been cured for at least 48 hrs. The well should not be placed in a pre-dredged hole. The sinking of the well shall be facilitated by excavating material uniformly from inside the dredge hole. Use of water jetting & divers may be adopted for sinking of well through harder strata with prior approval of the Engineer. The de-watering of well should not be used as a means for sinking of well. Contractor should take necessary precautions to avoid sand blows and he should be prepared at any point of time to tackle the sand blow problem, in case of any occurrence at no extra cost.

In the process of normal sinking any suitable method other than pneumatic sinking as necessary may be adopted. However, no claim due to any confirmations such as boulders, logs of trees met with during sinking or due to any other difficulty experienced in this process shall be entertained. The method to be adopted for sinking of well shall be approved by Engineer. For any change in method of sinking the Contractor shall obtain written permission from the Engineer-in-charge. During the operation of sinking of wells, the strata penetrated through and the behaviour of the well shall be reported to the Engineer. The decision of the Engineer on any matter pertaining to sinking shall be final and binding on the Contractor.

As the dredging is in progress, soil samples for the study of soil parameters should be collected for every meter depth and the sample should be preserved as per the standard approved practice by the Contractor at no extra cost. The depth of sump in well at any level should not be more than one metre. Further the depth of sinking of well for a particular stage shall be restricted to 1 metre to avoid the sudden sinking of well i.e., jumping of well. A record of depth of dredging from the original bed level should be maintained right from the commencement of sinking of well.

If the well is sunk beyond the founding level specified without prior approval of the Engineer due to any reasons, the Contractor will not be entitled for any extra cost. In case the top of the well project's beyond the required level due to unavoidable circumstance, it shall be responsibility of the contractor to dismantle such portion of work at his own cost. However the matter should be discussed with Engineer before any work in this regard is carried out.

9.5.1 Sinking History

The sinking history of well should be maintained in the format given in Appendix 1200/I of "Ministry of Road Transport & Highways - Roads & Bridges".

9.5.2 Use of Kentledge as Sinking Load

Kentledge shall be placed in an orderly and safe manner on the loading platform and in such a way that it does not interfere with the excavation of the material from inside the dredge hole and also does not in any way damage the steining of the well. When tilts are present or there is a danger of well developing a tilt, the position of the load shall be regulated in such a manner as to provide greater sinking effort on the higher side of well.

9.5.3 Use of Divers

Use of divers may be made both for sinking purpose like removal of obstruction, excavation etc and for inspection. All safety precautions shall be taken as per applicable safety code for sinking with divers or any statutory regulations in force. Only persons trained for the diving operation shall be employed and shall be certified to be fit for diving by an approved doctor.

The diving and other equipments shall be of acceptable standard and certified to this effect by an approved independent agency. Arrangements for ample supply of low pressure clean cool air shall be ensured through an armoured flexible hose pipe. Stand by compressor plant shall be provided in case of breakdown. All expenses incurred in use of divers, precautionary measures to be taken, casualties etc., will be at the Contractor's risk and own cost.

9.6 Precautions during Sinking

In case wells have to be sunk close to each other and clear distance between them is not greater than the diameter of well; sinking shall be taken up on all wells and they shall be sunk alternatively so that sinking of wells proceeds uniformly. Simultaneous and even dredging shall be carried out in wells in such a manner that the difference in the levels of the sump and cutting edge n the adjacent wells does not exceed half the clear gap between them. Preferably plugging of the wells close to each other can be done together.

Bore chart shall be referred to constantly during sinking for taking adequate care while piercing different types of strata. The type of soil as obtained during the well sinking should be compared with bore chart so as to take prompt decisions.

Before seasonal floods all wells sinking of which is in progress shall be sunk to sufficient depths below the designed scour level. Further they shall be temporarily filled and plugged so that they do not suffer any tilt or shift during the floods. The Contractor can ask for any details related to hydraulics like HFL,

LWL, scour depth etc., so as to plan his work suitably. Any losses incurred due to floods etc., by the Contractor due to improper planning of his work will be under Contractor's responsibility. No extra payment will be entertained in this regard.

All necessary precautions shall be taken against any possible damage to the existing foundations, prior to commencement of dredging from inside the well.

The dredged material shall not be allowed to accumulate over the well. It shall be dumped on the downstream and spread as far away as possible. In case the river stream flows along one edge of the well being sunk, the dredged material shall not be dumped on the dry side of the bank, but on the side on which the river current flows.

Very deep sump shall not be made below the well curb, as it entails risk of jumping (sudden sinking) of the well. The depth of sump shall be generally limited to $1/6^{th}$ of the outer diameter or 1m which ever is less.

In case a well sinks suddenly with a jerk, the steining of the well shall be examined to the satisfaction of the engineer to see that no damage has occurred to it.

De-watering shall be avoided if sand blows are expected. Any equipment and men working inside the well shall be brought out of the well as soon as there are any indications of a sand blow.

9.6.1 Tilts and Shifts

The tilt of any well shall not exceed 1 (horizontal) in 80 (vertical) and the shift at the well base shall not be more than 150mm in any resultant direction. Tilt's and shifts shall be carefully checked and recorded in the format given in appendix 1207. of "Ministry of Road Transport & Highways - Roads & Bridges" regularly during sinking operations. For the purpose of measuring the tilts along the two axes of the bridge, reduced level of the marks painted on the surface of the steining of the well shall be taken. For determination of shift, locations of the ends of the two diameters shall be precisely measured along the two axes, with reference to fixed reference points.

The check for occurrence of tilt should be made every day before the commencement of the work and the readings/ findings should be properly recorded and maintained. The check for shift shall be done for every 1.5m of sinking of well. These recordings shall also be properly maintained.

Whenever any tilt is noticed, adequate preventive measures like placing eccentric kentledge, pulling, strutting, anchoring or dredging unevenly and depositing dredge material unequally, putting obstacles below cutting edge, water jetting etc. shall be adopted before any further sinking. After rectification, the

dredging shall be uniform and dredged material shall be spread out uniformly. A pair of wells close to each other i.e., where clear distance between well is not greater than the diameter of well, they have tendency to come closer while sinking. Timber struts may be introduced in between the steining of these wells to prevent tilting.

In the event of a well developing tilt or shift beyond the specified permissible values, the contractor shall have to carry out, at his own cost, suitable remedial measures to the satisfaction of the Engineer, to bring the tilt and shift within the permissible values, as for as practicable.

If the resultant tilt and /or shift of any well exceed the specified permissible values, the well so sunk shall be regarded as not conforming to specification and a sub standard work. Generally it should not exceed 1 in 50 and 300 mm respectively. The Engineer in his sole discretion, may consider accepting such a well, provided the calculations for foundation pressure and steining stresses, accounting for the actual tilt and shift furnished by the contractor show that well is safe. Any remedial measures required to bring the stresses within permissible values (such as increase in the dimension of the well cap, provision of dummy weights on the well cap) shall be carried out by the contractor without claiming for any extra cost.

In case the Engineer, in his discretion rejects the well, the contractor shall dismantle the rejected well to the extent directed by Engineer and remove the debris. Further the Contractor shall at his own risk and expense complete the bridge with modifications acceptable to the Engineer. The wells which are not conforming to the specified limits of tilts and shifts, if accepted for one or other reasons will be penalised in the form of lump-sum deductions per meter length of well which will be at the discretion of Engineer.

9.6.2 Seating of Well

The well shall be uniformly seated at the founding strata. After the well has been evenly seated on good hard rock, arrangements shall be made to facilitate proper inspection in dry and visible conditions before the bottom plug is laid. The founding levels shown in the drawings are purely based on the data available from geo-technical investigations. The Engineer on inspection will decide upon any modifications that may be required to meet the structural aspects. The bottom plugging shall be commenced only after this inspection and concurrence from Engineer.

9.6.3 Tolerances for Well Steining and Well Cap

The permissible tolerances are as follow:

(a)	Variation in dimension	:	+ 50mm - 10mm
(b)	Misplacement from specified position	:	15mm

(c) Surface Irregularities measured with 3m straight edge : 5mm

(d) Variation of levels at the top : ± 25mm

9.6.4 Measurement for Payment of Sinking of Well

The depth of sinking shall be measured from the natural bed level to the bottom of the well curb.